

**STATUS OF MINERAL RESOURCE INFORMATION FOR THE  
TULE RIVER INDIAN RESERVATION, AND SEVERAL  
OTHER CENTRAL CALIFORNIA INDIAN LANDS**

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## INTRODUCTION

### General

This report was prepared for the U.S. Bureau of Indian Affairs by the U.S. Bureau of Mines and the U.S. Geological Survey under an agreement to compile and summarize available information on the geology, minerals, energy resources, and potential for economic development of certain Indian lands. Sources of information were published and unpublished reports; the Mineral Industry Location System (MILS) files of the U.S. Bureau of Mines; and personal communications.

In June 1977, U.S. Bureau of Mines personnel spent a week visiting selected central California Indian reservations and rancherias. These brief visits were necessary because an understanding of the geography, nearby mining activity, living conditions, and general economic development of the small areas was not obtainable from the literature. One day was spent at the Tule River Reservation, collecting samples and examining an inactive tungsten mine and a dolomite deposit.

### Map Coverage

Figure 1a, Figure 1b, Figure 1c, and Figure 1d show locations of the rancherias and reservations and topographic maps available.

### Acknowledgments

Mr. Emmet R. Lynch, Realty Officer, Central California Indian Agency, Sacramento, California, provided up-to-date information about the reserva-

tions and rancherias. Mr. Alec Garfield, Chairman of the Tule River Tribal Council, granted permission for Bureau of Mines personnel to visit the reservation; provided information on past tungsten mining; and permitted the use of a private consultant's report concerning a dolomite deposit in the northeastern part of the reservation. Mr. Oliver E. Bowen, formerly a geologist with the California Division of Mines and Geology and now a consulting geologist, supplied unpublished data on limestone/dolomite deposits on the Tule River Indian Reservation.

## SIERRA NEVADA PROVINCE

The Sierra Nevada province is approximately 400 miles long, extending from the Mojave Desert on the south to the Modoc Plateau in the north, and is 50 to 80 miles wide (Figure 2). The Sierra Nevada is essentially a huge crustal block which has risen along a series of faults on its eastern side and tilted westward. The southern part of the Sierra Nevada and the eastern portion of its northern part consist primarily of Mesozoic plutonic rocks. The west side of the northern part is a belt of Mesozoic and Paleozoic metamorphic rocks that includes the famed Mother Lode country (Bateman and Wahrhaftig, 1966). To the west, the Sierra Nevada is overlapped by sedimentary rocks of the Great Valley and on the north by volcanic rocks of the Cascades and the Modoc plateau.

## TULE RIVER INDIAN RESERVATION

### Location

By paved road, the Tule River Indian Reservation is about 8 miles east of Porterville in Tulare County, California. It contains 54,116 acres and has a population of approximately 300 (U.S. Dept. of Commerce, 1974, p. 160). Tribal headquarters are in a new building adjacent to the main road on the reservation, about 1.5 miles from the western boundary. The reservation encompasses almost the entire drainage basin of the South Fork of the Tule River (Figure 3).

The climate is characterized by hot, dry summers and cool, rainy winters. Average temperatures range from about 45°F in January to 85°F in July. Precipitation occurs mainly between November and May, and ranges from less than 20 inches annually in the lower elevations to more than 45 inches in the higher mountains. During the winter, snow accumulates above 5,000 feet.

South-facing slopes tend to be open and grassy. North-facing slopes and the creek bottoms are forested and brushy. Vegetation includes oak, pine, cedar, madrona, chaparral, and various kinds of grasses.

The topography is rugged. Perennial streams have deeply incised the terrain forming steep, narrow canyons and prominent ridges, with relief exceeding 6,000 feet. Gently sloping, or relatively flat, benches are common at higher elevations.

Access to the reservation is by a paved road leading from State Highway 190 east of Porterville. This road is paved on the reservation as far as the abandoned sawmill, 5.5 miles from the western

boundary (Figure 3). From the sawmill, a graded, narrow, winding dirt road climbs from the valley and follows the canyon of the South Fork of the Tule River to the northeast corner of the reservation; it is passable by car as far as the Cholollo Campgrounds (Figure 3). The road beyond is rough but can be negotiated during dry weather. A branch road leads to the southeastern part of the reservation via the Eagle and Kessing Creek drainages. In addition, there are numerous trails and jeep roads.

Except for the sale of camping permits, the tribe now has no income from reservation land. In the past, the now-abandoned sawmill was the reservation's only major industry.

### Geology

The geology of the reservation (Figure 3) consists essentially of pre-Cretaceous metasediments intruded by Jurassic-Cretaceous granitic rocks. The metasedimentary rocks consist of schist, metachert, phyllite, quartzite, hornfels, tactite, slate, and marble. The lithologies are unnamed and mapped as undifferentiated on the Geologic Map of California, Fresno 2° sheet (Matthews and Burnett, 1965). Associated with the metasediments but mappable as separate units are pre-Cretaceous metamorphosed limestones and dolomites.

Jurassic-Cretaceous granitic rocks ranging in composition from granite to gabbro have intruded the metasediments. Quartz diorite and diorite occur in the northwest; the southern areas consists of the Mesozoic Summit Gabbro which is a fine-grained, locally pegmatitic, mafic intrusive ranging in composition from diorite to hornblendite.

## Mineral Resources

### General

Tungsten is the only mineral commodity known to have been mined, but no production figures could be found. Tungsten, gold, copper, molybdenum, limestone, stone, magnesite, crushed rock, and sand and gravel have been produced just outside the reservation. The nearest active mining operations are gravel quarries and a limestone quarry near Porterville.

### Metallic Mineral Resources

#### Tungsten

Between 1932 and 1955, tungsten production in Tulare County was 136,192 units (1 unit=20 pounds of contained  $WO_3$ ), from as many as 30 mines. The more important producers were the Consolidated Tungsten mine (about 40 miles northwest of the reservation), the Tulare County Tungsten mine (about 15 miles north), and the Tungstore mine (about 12 miles south). Some production was from several small mines just north and south of the reservation. By 1957, most of the mines and mills in Tulare County were idle (Goodwin, 1958, p. 346-347; Krauskopf, 1953, table 3).

Some tungsten was produced from the NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 11, T. 22 S., R. 30 E. (Figure 3). This is probably referred to in the literature as the Tule Indian Reservation mine (Jenkins, 1942, p. 357; Krauskopf, 1953, p. 82) and also the Johnson claim (Goodwin, 1958, p. 446). Jenkins and

Krauskopf each give the location as being in sec. 7, T. 22 S., R. 30 E. Goodwin locates the Johnson claim in the northeast corner of the reservation south of Camp Nelson, and mentions that the prospect was active in 1954.

However, according to Mr. Alec Garfield, Chairman of the Tule River Indian Reservation Tribal Council, tungsten was produced from only one location on the reservation.

The mine workings are on the south slope of a ridge, about 300 feet upslope from the main road. They can be reached by an old access road, which is now washed out, overgrown, and impassable to vehicle traffic. Development consists of a north-trending adit about 60 feet long, driven along the contact between granitic rock and metamorphosed sedimentary rock. The ore was trucked to the Johnson tungsten mill, 20 miles from the mine in the SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 30, T. 21 S., R. 29 E., on the north bank of the South Fork of the Tule River about 4 miles east of Porterville. No description of the geology, history, or production of this mine could be found in the literature.

The tungsten deposits of the western Sierra Nevada are nearly all concentrations of scheelite in tactite. The most common variety of tactite is a fine- to medium-grained garnet-pyroxene rock containing quartz, calcite, epidote, amphibole, wollastonite, and sulfides. Scheelite generally occurs in the garnet-rich tactite as disseminated yellow-fluorescing grains (Krauskopf, 1953, p. 80).

The tungsten deposit at the Tule River Reservation mine is typical of those found throughout the western Sierra Nevadas. The tactite is irregularly distributed as pod-like masses along the contact between a granitic intrusive and calcareous

metasediments. A chip sample from the ore zone at the portal analyzed 12 percent  $\text{WO}_3$ , 370 parts per million (ppm) molybdenum, 140 ppm zinc, and 21 ppm copper. Several specimens of tactite from the ore bin were combined into one sample, which analyzed 7 percent  $\text{WO}_3$ , 120 ppm molybdenum, 150 ppm zinc, and 38 ppm copper.

The yellow fluorescence of the tungsten minerals results from the presence of molybdenum, which has replaced some of the tungsten in the scheelite. As little as 1 percent molybdenum will cause a distinct yellow fluorescence in scheelite, which, when almost pure, fluoresces a brilliant blue-white (Kerr, 1946, p. 74). Many tungsten ores contain up to 5 percent molybdenum. Because of their chemical similarities, it is difficult to separate tungsten and molybdenum in the metallurgical process.

J. H. Kleinfelder and Associates (1977, p. 16) report a small pod of tactite along the contact between a dolomite unit and granitic rock in the northeastern part of the reservation. They found no scheelite.

## Gold

Free gold with abundant pyrite occurs in shallow quartz veins in granitic rock on the northeast slopes of Cow Mountain, just north of the reservation (Figure 3). This area, the Globe mining district, was prospected in the early 1900's (Clark, 1970, p. 52). Workings consisted of several shallow shafts and short adits.

The Creeks mine, part of the Southern Mother Lode group, was at about 2,680-foot elevation. A series of narrow, parallel quartz veins in granite

strike N. 45° W. and dip 40° SW. Mine workings are by several short adits and shallow shafts (Tucker, 1917, p. 139).

The Florence G. holdings were at 3,300-foot elevation in secs. 30 and 31, T. 21 S., R. 30 E. The claim group included the Florence G. mine, the Florence G. mill site, and the Black Bear group. At the Florence G. mine, a series of parallel fissure veins in granitic rock strike N. 45° E. and dip 35° SE. The quartz contains free-milling gold and 2 percent iron sulfides. Workings consisted of two adits; one 140 feet and the other 150 feet long (Tucker, 1917, p. 140).

No information on any recent activity in the Globe district could be found.

Gold has also been produced from the White River district about 11 miles south of the reservation. A series of west-northwest-trending parallel quartz veins occur in shear zones in granodiorite. The ore contains free gold and small amounts of pyrite. This district had yielded an estimated total of \$750,000 worth of gold by 1914; most mining was prior to 1906 (Clark, 1970, p. 131).

## Molybdenum

Molybdenum reportedly was produced in 1905 from three locations in sec. 10, T. 21 S., R. 31 E., about ½ mile northeast of the reservation. These deposits were on Griders claim (Goodwin, 1958, p. 437).

## Copper, Zinc, Lead, and Silver

The nearest copper occurrences are about 7 miles northeast of the reservation. Tucker (1917, p.

134) reports that copper occurs in "narrow diverging seams or stringers."

"About 30 zinc-lead-silver prospects have been reported in Tulare County, but none of them has developed beyond the prospect stage....Sphalerite (zinc sulfide) and argentiferous galena (lead sulfide containing some silver) occur in metamorphosed sedimentary rocks, especially limestone, near contacts with intrusive granitic rocks. The common gangue minerals in such deposits are quartz, calcite, and a large variety of calc-silicate minerals" (Goodwin, 1958, p. 370).

The contact aureoles between the granitic rocks and the metasedimentary rocks on the reservation might have been favorable for zinc-lead-silver mineralization.

## **Nonmetallic Mineral Resources**

### **Limestone and Dolomite**

Occurrence.--Carbonate rocks (limestone, dolomite, marble, and intermediate varieties) are common in Tulare County. However, their remoteness from the major marketing centers has discouraged development of mining operations (quarries).

The limestone pendants tend to be lenticular with their long axes trending north or northwest. Associated rocks include hornblende amphibolite, quartz-mica schist, and slate. Granitic intrusions have cut many of the pendants. Siliceous metamor-

phic rocks have been formed along many of the granite-limestone contacts (Goodwin, 1958, p. 376).

Limestone has been quarried intermittently since the early 1900's by the Porterville Limestone Co. at the Worth deposit in secs. 12 and 13, T. 22 S., R. 28 E., about 4 miles west of the reservation. The crushed product has been used as a supplement in cattle feed. The limestone is of a high purity, but excessive silica has caused some problems in maintaining quality. One hand-picked sample contained 55 percent CaO (Bowen, 1976, personal commun.). Bowen (1973, pl. 1) classifies this deposit as a minor active deposit having less than 20 million tons.

The South Fork of the Tule River limestone and dolomite deposit is in sec. 11, T. 22 S., R. 30 E., near the Tule River Indian Reservation tungsten mine. It is classified by Bowen as a minor, inactive deposit with less than 20 million tons of reserves. Analyses of three samples from the deposit are listed in [Table 1](#). Bowen (1976, personal commun.) believes that the limestone from this deposit might be suitable for sugar beet processing, in refractories, or as agricultural lime.

TABLE 1  
 Analyses of Three Samples from the South Fork of the Tule River Limestone-dolomite Deposit  
 (From Bowen, 1976, personal commun.)

	No. 1	No. 2	No. 3
SiO <sub>2</sub>	0.95	1.0	1.2
Al	.00	.20	.00
Fe <sub>2</sub> O <sub>3</sub>	.30	.19	.33
MgO	20.9	20.7	20.8
CaO	30.0	30.5	30.0
P <sub>2</sub> O <sub>5</sub>	.04	.05	.04
Loss on ignition	<u>46.8</u>	<u>46.7</u>	<u>46.6</u>
TOTAL	98.99	99.34	98.97

The Blue Canyon Creek limestone deposit (sec. 5, T. 22 S., R. 30 E., north of Soda Springs) and the Gibbon Creek limestone (sec. 18, T. 22 S., R. 30 E.) are both classified by Bowen as major undeveloped deposits, each containing more than 20 million tons. The Cow Mountain limestone is classified as a minor inactive deposit containing less than 20 million tons.

Another dolomite deposit is in parts of secs. 29, 30, 31, and 32, T. 21 S., R. 31 E., (Figure 3). About 10 miles of the access road is unpaved, narrow, and winding. The Cholollo Campground is southeast of and adjacent to the deposit. During the past 5 years, several companies have investigated the deposit. In 1976, the Tule River Indian Reservation Tribal Council and the Bureau of Indian Affairs hired the consulting firm of J. H. Kleinfelder and Associates of Fresno, California, to make a detailed examination of it. Field reconnaissance, geologic mapping, geophysical surveys, including ground magnetometer and seismic

refraction techniques, test drilling, and laboratory analyses were conducted.

The area is rectangular in shape and approximately 10,000 feet long and 3,000 feet wide (Figure 3) and is along the western margin of a metamorphosed roof pendant. The metamorphic rocks consist primarily of carbonate rocks (limestone, dolomitic marbles, and dolomite), quartz-biotite schist, hornfels, and tactite, which have been complexly folded and faulted. Granitic rocks crop out along the western margin of the area studied (Kleinfelder and Assoc., 1977, p. 8-9).

Kleinfelder geologists identified three blocks of carbonate rocks. These are the north, central, and southern pods (Kleinfelder and Assoc., 1977, pl. 1) which are separated from each other by several hundred feet of schistose rock.

The northern pod is the largest and consists primarily of dolomite interbedded with thin layers of quartz-mica schist. The dolomite is medium grained, white to light gray on fresh exposures, and

weathers to a grayish orange to a dark gray. Secondary minerals include chlorite, calcite, and feldspar. Minor minerals are diopside, hornblende, illite, kaolinite, and quartz (Kleinfelder and Assoc., 1977, p. 10). The contact of the dolomite with the hornfels unit to the west is quite sharp. Kleinfelder geologists interpreted this contact to be a thrust fault. The eastern contact is a transition zone of interbedded dolomite and schist. The northern contact is a granite pegmatite (Kleinfelder and Assoc., 1977, p. 10-11).

The carbonate rocks in the central and southern pods are predominantly silica-bearing limestone marbles containing numerous beds of quartz-mica schist and hornfels. Fresh carbonate rock ranges from white to light gray; weathered surfaces range from gray to orange and dark gray. The contacts are obscured but appear to be sharp (Kleinfelder and Assoc., 1977, p. 11).

In the dolomite from the northeastern part of the reservation, silica, kaolinite, and chloritic clay are common impurities. Silica is finely disseminated throughout the carbonates, and as discrete silt or sand-sized grains of quartz within beds of fine-grained quartz-mica schist. Most of the clay and silica impurities occur within the schist units, which are widely-spaced and relatively thin. Disseminated organic matter, in the form of finely-disseminated dark-colored microcrystalline graphite, is a common but minor constituent (Kleinfelder and Assoc., 1977, p. 28-29).

Kleinfelder geologists do not consider any of the impurities in the dolomite to be a detriment to the development of a commercial operation. The clay, silica, and organic material are too widely spaced and fine-grained to affect the overall quality

of the deposit. They believe the carbonate rocks in the northern portion of the study area are the only ones having an economic potential at this time. Those in the central and southern pods are not of sufficient tonnage, are of poor quality, and/or would pose certain access and developmental problems. The northern deposit is estimated to have a thickness of at least 100 feet. In a 100-foot section, the overburden is about 15 feet and the dolomitic marble about 85 feet thick. The 85 feet of dolomitic marble is composed of approximately 50 feet of medium-dense rock and about 35 feet of very dense rock (Kleinfelder and Assoc., 1977, p. 22).

The indicated reserves of the northern deposit are estimated to be about 2,541,000 tons of medium-dense dolomite and 1,930,000 tons of dense dolomite. The inferred reserve is computed to be 5,500,000 tons per 100 feet of depth (Kleinfelder and Assoc., 1977, p. 226).

Uses and Specifications.--The uses of carbonate rock (limestone and dolomite) depend largely on physical properties, chemical properties, or both. Physical properties are more important if the rock is used "as is," such as for aggregate or building stone. Chemical properties are more important if the rock is changed into a different form before use, e.g., the manufacture of cement or lime. Chemical and physical properties are often interrelated, e.g., the whiteness of limestone or dolomite is a function of the chemical purity of the rock. Specifications for different uses are listed in [Table 2](#). [Table 3](#) lists chemical analyses of drill core samples from the northeastern part of the reservation.

## Dimension Stone

Dimension stone was produced in Tulare County between 1889 and 1953. Granite valued at \$700,000 was produced from quarries in the foothills east of Porterville and Exeter between 1889 and 1933. The principal rocks quarried were a dark-gray gabbro-diorite (Porterville black granite) and a pale gray biotite granite (Porterville white granite). These are found as residual boulders and in massive outcrops that underlie the low hills on the east side of the San Joaquin Valley. The rock was used as monumental stone, building stone, and curbing. From 1933 to 1953, production was restricted to small quantities of black granite (Goodwin, 1958, p. 390).

The Porterville black granite quarry is in the NW¼ sec. 29, T. 21 S., R. 29 E., about 3 miles northwest of the reservation. The Porterville white granite quarry is in sec. 27, T. 21 S., R. 28 E., about 2 miles northeast of Porterville.

Goodwin (1958, p. 472) mentions a deposit of dark-gray marble known as the Jones marble, located about 8 miles southeast of Porterville on the road to the Tule River Indian Reservation.

Granitic rock, limestone, dolomite, and possibly marble are in massive exposures on the reservation. Some of these may have dimension-stone potential.

## Magnesite

Magnesite (magnesium carbonate-- $\text{MgCO}_3$ ) is a white to grayish-yellow or brown mineral. It is usually found as earthy masses or irregular veins formed from the alteration of limestone and dolo-

mite by magmatic solutions or from the alteration of rocks rich in magnesium silicates. Magnesite is sometimes an ore of magnesium but is used chiefly in making refractories and magnesia.

Magnesite mining was important in Tulare County between 1900 and 1931. Annual production rose from 2,500 tons in the early 1900's to a peak of 136,562 tons in 1917, when Tulare County magnesite deposits and those in Washington State were the only domestic sources of supply. Some of the material was calcined locally and some was shipped to the San Francisco Bay area for calcining. Most of the magnesia from California magnesite was used to digest and whiten pulp in Oregon paper mills. By 1931, the magnesite resources were depleted and mining ceased. Over 500,000 tons valued at 5 million dollars had been produced (Goodwin, 1958, p. 381, 383).

The Tulare County magnesite lies in a belt that trends northwest from the Porterville deposit, 4 miles east of Porterville, to an area 3 to 6 miles east of Exeter, 22 miles northwest of Porterville. The magnesite has formed as "supergene fracture fillings in weathered serpentinite below a laterized surface" (Goodwin, 1958, p. 383). Most of the workings were shallow; selective mining and hand sorting were necessary.

## Sand and Gravel

Currently there are no sand and gravel pits on the reservation. Sand and gravel are quarried from the Tule River floodplain near Porterville.

The relatively narrow canyons and steep gradients of the reservation's streams are not favorable for the accumulation of sand and gravel. However,

some might be obtained for local use from the valley of the South Fork of the Tule River in the west central part of the reservation.

## **Barite**

Barite (barium sulfate -  $\text{BaSO}_4$ ) occurs as residual remnants (spuds) and sand in a matrix of red clay on the weathered surface of a baritic limestone about 2 miles north of the reservation in the SW $\frac{1}{4}$  sec. 33, T. 20 S., R. 31 E. The baritic limestone is about 2 feet thick in outcrop and is underlain by siliceous limestone, quartzite and block slate, and overlain by 25 feet of limestone. The deposit was worked in 1958 (Goodwin, 1958, p. 371).

## **Conclusions and Recommendations for Further Work**

The Tule River Indian Reservation has potential for tungsten, dolomite, limestone, stone, and perhaps gold. All these commodities have been produced nearby; tungsten has been mined from reservation land. The distance of the limestone and dolomite units from major marketing areas is a discouraging factor in their future development.

Detailed geologic mapping, with special attention to the contacts between the granitic intrusives and the metasedimentary rocks, is needed. Stream sediment sampling would be helpful in locating mineralized areas. Soil sampling near the known tungsten occurrences, and as a follow up to stream sampling, could further define the extent of the mineralized zones. The areas of the reservation

containing potential limestone and dolomite reserves should be studied in more detail.

## **BERRY CREEK AND ENTERPRISE RANCHERIAS**

### **Location**

The Berry Creek Rancheria is in Butte County in the NE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 5, T. 20 N., R. 6 E., about 27 miles northeast of Oroville, and 1 mile north of the inundated Middle Fork of the Feather River ([Figure 4](#)). It contains approximately 33 acres and has an estimated population of 2 (U.S. Dept. Commerce, 1974, p. 82). It lies in the western foothills of the Sierra Nevada at about 1,600 feet altitude in an area of rolling uplands and steep-sided stream-cut canyons. Most of the rancheria consists of valley slopes at the headwaters of Bean Creek. During the winter and the rainy season, access is very difficult, even with four-wheel-drive vehicles. Commercial air, train, truck, and bus services are available at Oroville (U.S. Dept. Commerce, 1974, p. 82).

The Enterprise Rancheria is in Butte County in the NE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 25, T. 20 N., R. 5 E., about 20 miles east-northeast of Oroville, midway between the Middle and South Forks of the Feather River ([Figure 5](#)). It consists of 40 acres and has an estimated population of 4 (U.S. Dept. Commerce, 1974, p. 102). The rancheria's altitude ranges from 1,400 to 1,600 feet, and, like the Berry Creek Rancheria, is an area of rolling uplands. Access from Oroville is good over both paved and graded roads.

## Geology

Both the Berry Creek and Enterprise Rancherias are on granitic rocks of the Jurassic-Cretaceous Bald Rock batholith that include Paleozoic and Mesozoic metavolcanics and meta-sediments of the Oregon City Formation which may crop out including (1) metabasalt, (2) meta-rhyolite, (3) metadacite, (4) hornblende and amphibolite schist, (5) diabase, (6) amphibolite, and (7) quartz and hornblende porphyries. The eastern portions of the batholith also intrude rocks of the Paleozoic Calaveras Formation which include schist, slate, quartzite, crystalline limestone, argillite, and chert.

The Bald Rock batholith is composed of several gradational rock types including (1) tonalite, (2) granodiorite, (3) trondhjemite, and (4) leucotondhjemite (Compton, 1955). The bedrock on the Enterprise Rancheria consists entirely of trondhjemite, a quartz-rich quartz diorite. Bedrock of the Berry Creek Rancheria consists mostly of trondhjemite and leucotondhjemite, but granodiorite crops out in the extreme southeast corner. Mesozoic ultrabasic intrusive rock may occur locally and are mostly serpentized with minor amounts of talc schist and soapstone.

Patches of Tertiary auriferous gravels may in places overlie both the intrusive rocks and the metavolcanics and metasediments. These are remnants of primarily Eocene to Miocene stream channels, although some of the auriferous gravels are as young as Pliocene. These gravels are characterized by high percentages of quartz clasts, and are interbedded with clay, sand, and locally lignite or coal.

In many places, the Tertiary gravels are capped by younger Tertiary and Quaternary volcanic flows and volcanic-derived sediments. Basaltic, andesitic, and rhyolitic flows are interbedded with mud flows, tuff, tuff breccia, and volcanic gravel (California Department of Water Resources, 1960).

## Mineral Resources

There are no known mineral resources on either the Berry Creek or the Enterprise Rancherias. Their small sizes and the fact that they are underlain by relatively uniform granitic rock are not favorable factors for the development of a recoverable mineral resource. Gold has been produced from the Forbestown district, 3 to 6 miles southeast of the rancherias; the Bidwell Bar area, about 5 miles west of the Enterprise Rancheria; and from dredging operations on the Feather River near Oroville. In addition, there has been some copper, lead, and zinc production from the Big Bend (Evening Star) mine about 8 miles northwest of the Berry Creek Rancheria (O'Brien, 1948b, p. 433).

The Forbestown mining district is about 3 miles east-southeast of the Enterprise Rancheria. The Feather River, which drains the area, yielded large amounts of placer gold during the 1849 gold rush. Lode mining predominated from the mid-1880's to the early 1920's. Moderate mining activity persisted through the 1930's, and intermittent prospecting has continued up to the present time (Clark, 1970, p. 48-49).

The Bidwell Bar district, about 10 miles northeast of Oroville, west of the Junction of the South and Middle Forks of the Feather River, is 4 miles

southwest of the Enterprise Rancheria. Gold was discovered here in 1848 and a general rush to the Feather River region followed. Today, much of the area has been inundated by Oroville Lake (Clark, 1970, p. 29-30).

Most gold at Bidwell Bar was obtained from Recent and Pleistocene gravels in and adjacent to the river. There are, however, a few narrow quartz veins. The district is underlain by amphibolite in the west and granite in the east (Clark, 1970, p. 30).

## **COLD SPRINGS RANCHERIA**

### **Location**

The Cold Springs Rancheria, population 62, is approximately 42 miles northeast of Fresno and 5 miles north of Pine Flat Lake in Fresno County. The rancheria consists of approximately 98 acres in sec. 14 and 15, T. 11 S., R. 24 E. It is accessible by Highway 168 from Fresno, and by the Burrough Valley and Sycamore roads, all of which are paved (Figure 6). The Sycamore road is narrow, winding, and poorly paved to the rancheria. The rancheria lies at an altitude of approximately 1,500 feet in an area of the western Sierra Nevada characterized by steep-walled canyons separated by 3,000-foot ridges.

### **Geology**

Bedrock in the rancheria area (Figure 6) consists of Jurassic(?) "Dinkey Creek"-type hornblende-biotite granodiorite migmatites and

possibly Jurassic hornblende gabbro, hornblende-pyroxene gabbro, hornblendite, quartz-gabbro, and mafic quartz-diorite. Metamorphic rocks including fine-grained micaceous schists with interbedded quartzites and metavolcanics may occur on the northwest part of the rancheria (Krauskopf, 1953).

The migmatites, which are formed by assimilation and hybridization of the metamorphics by Jurassic intrusive igneous rocks are found in a northwest-trending zone several miles wide. Most of the Fresno County tungsten deposits are located in this zone (Krauskopf, 1953). Economic concentrations of scheelite occur only in lime-rich rocks, and the best ore is found in fractured zones where beds are cut off by intrusive rock (Krauskopf, 1953). The size of tactite deposits is variable, ranging from small pods less than 1 foot long to continuous layers hundreds of feet long. Scheelite is unequally distributed throughout the tactite, and ore bodies commonly have no lateral or vertical persistence.

### **Mineral Resources**

The Adrian Alexander tungsten mine (also known as the Red Bud and Spanish Peak) is in the E½SE¼ sec. 15, T. 11 S., R. 24 E., less than 1 mile south of the western section of the rancheria at about 1,600 feet altitude. Scheelite occurs in small, scattered bodies of tactite associated with schist. Some samples contained 1 to 2 percent WO<sub>3</sub>. A body of tactite, about 30 feet long and 2 feet wide, exposed in an adit, averaged 1 percent WO<sub>3</sub> (Krauskopf, 1953, p. 76).

The deposit has been prospected by a short adit and a number of surface cuts. The footwall is in

granite and the hanging wall in limestone. The contact strikes north to N. 20° W. (Krauskopf, 1953, p. 76; Logan, Braun, and Vernon, 1951, p. 534). The last load of concentrate was shipped in 1954. Total production value was a few thousand dollars (Wallace, McLenegan, and Matson, 1957, p. 208).

The Jackpot mine is at about 2,500 feet altitude in the SE¼ sec. 9, T. 11 S., R. 24 E., about 1 mile northwest of the western section of the rancheria. Scheelite occurs in a body of tactite 200 by 70 feet. One layer of tactite 3 feet wide and 50 feet long contained several percent WO<sub>3</sub>. The rest is barren or contains less than 0.5 percent WO<sub>3</sub>. Development consists of several small pits and 2 short adits (Krauskopf, 1953, p. 77). This mine accounted for a major part of the 50,000 pounds of tungsten concentrate shipped from Fresno County in 1956. During this time, the ore was being mined from an open pit (Davis, Branner, and Ashizawa, 1958, p. 215).

There are several other small mines and prospects within a 5-mile radius of the rancheria. Work on these claims, along with the Adrian Alexander and the Jackpot, ceased when the government stockpile purchase program ended in the late 1950's. Chromite has been produced from the Hog Mountain area about 6 miles south of the rancheria. The deposits are primarily low-grade, with most of the better grade material being removed between 1915 and 1919. The chromite occurs in a northwest-trending belt of peridotite and serpentinite about 1 mile wide and 11 miles long (Logan, Braun, and Vernon, 1951, p. 493).

## JACKSON RANCHERIA

### Location

The Jackson Rancheria is approximately 35 miles southwest of Sacramento and 4 miles north-east of Jackson, in Amador County. It contains 331 acres in secs. 11 and 17, T. 6 N., R. 11 E., and has a population of about 7 (U.S. Department of Commerce, 1974, p. 116). It is approximately 5 miles north of the Mokelumne River in an area of the western Sierra Nevada foothills characterized by tablelands and rolling uplands deeply incised by streams (Figure 7). The rancheria is covered with abundant vegetation. The Amador Canal crosses the eastern boundary. Access is good, especially from the west where the paved road from Jackson crosses the boundary. A narrow paved road enters the rancheria from the west and extends east for about 1 mile to a homesite.

### Geology

The bedrock of the Jackson Rancheria area (Figure 7) essentially consists of Paleozoic marine metasedimentary rocks of the Calaveras Formation intruded by Jurassic-Cretaceous granitic rocks. In the rancheria area, the most common rocks are fine-grained rocks of the Calaveras Formation, including siltstone or quartz-mica schist and black slate interbedded with pyroclastic rocks, thin graywacke beds, and rhythmically-bedded recrystallized radiolarian cherts. Small lenses of black limestone occur locally, as well as phyllite, sheared sandstone, quartzite, gneiss, and meta-conglomerate (Clark, 1964).

The metamorphic and plutonic rocks are locally overlain by small patches of Tertiary auriferous channel gravels which are characterized by high percentages of white quartz pebbles, cobbles, and boulders. Placer gold concentrations are generally richest on the bedrock surface.

## Mineral Resources

The rancheria lies in the Sierra Nevada East Gold Belt in a district first worked during the gold rush. Gold-quartz veins intrude the Calaveras Formation and have yielded rich pockets of ore containing gold, as well as other sulfide minerals including galena and chalcopyrite (Clark, 1970). The area has been heavily prospected, but no reference could be found of any mining activity on or adjacent to the rancheria.

From the 1890's until 1942, the part of the Mother Lode that includes the Jackson area was one of the most important gold mining districts in the nation. Production was valued between \$2 million and \$4 million annually (Clark, 1970, p. 69-70). The major mines in the area and the total production during their working lives were as follows: Argonaut, \$25.2 million; Central-Eureka group, \$36 million; Kennedy, \$34.28 million; South Eureka, \$5.3 million; Zeila, \$5 million; and Oneida, \$2.5 million (Clark, 1970, p. 76).

All gold mines in the district were closed at the beginning of World War II. The Central Eureka mine was reopened in 1946, but greatly increased costs forced its closure again in 1953. It was the last major active gold mine on the Mother Lode (Clark, 1970, p. 73).

The ore deposits in the district are in massive, sheared quartz veins, sometimes tens of feet thick, which are mainly in slate of the Mariposa Formation. The ore bodies contain disseminated free gold, along with pyrite and minor amounts of other sulfides, which commonly average 1 to 2 percent of the ore (Clark, 1970, p. 76).

The Pine Grove district, near the town of Pine Grove, about 10 miles east of Jackson, is 3 miles northeast of the rancheria. It was first worked during the gold rush, and has been prospected intermittently since. The district is underlain chiefly by graphitic slate, schist, and chert; it is bordered by granodiorite on the east and west. Gold, along with abundant sulfides, especially galena and chalcopyrite, occurs in narrow quartz veins. A few small patches of auriferous Tertiary channel gravels overlie the bedrock (Clark, 1970, p. 105).

## SHEEP RANCH RANCHERIA

### Location

The Sheep Ranch rancheria is in Lot 1, Block 14, of the NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 8, T. 4 N., R. 14 E., in central Calaveras County, approximately 18 miles east of the town of San Andreas and 50 miles southeast of the Sacramento ([Figure 8](#)). The rancheria lies in the northeast part of the town of Sheep Ranch, and has an area of 0.92 acres and a population of 1 (U.S. Department of Commerce, 1972, p. 149). It lies on a ridge between O'Neill and San Antonio Creeks about 13 miles from the confluence of the North and Middle Forks of the

Stanislaus River, at approximately 2,400 feet altitude.

## Geology

The rocks in the area of the Sheep Ranch Rancheria (Figure 8), can be divided into two major assemblages, (1) the "Bedrock Series" consisting of steeply dipping Paleozoic metamorphic rocks and Mesozoic intrusive rocks, and (2) the "Superjacent Series" consisting of an overlying veneer of Tertiary sedimentary and volcanic rocks (Clark and Lydon, 1962).

The Paleozoic Calaveras Formation, a suite of undivided metamorphic rocks, underlies most of the Sheep Ranch area and locally includes, (1) fine-grained impure quartzite, (2) graphitic schist, and (3) low-grade carbonaceous slate. The beds strike generally northwest and dip steeply eastward.

Small lenses of Jurassic serpentine occur locally, ranging from green to black in color and occurring as massive or foliated and slickensided. The serpentine is associated with gabbro, talc, mariposite-ankerite, chrysotile veinlets, and scattered pods of chromite (Clark and Lydon, 1962).

The Paleozoic and Jurassic rocks are cut by Upper Jurassic-Cretaceous granitic intrusives including granite, granodiorite, quartz diorite, diorite, and gabbro. The most abundant intrusive rock is hornblende granodiorite, although gabbro is common. Gold-quartz veins are associated with these late Mesozoic intrusives and cut all of the older rock units. In the Sheep Ranch vicinity, the quartz veins are as much as several feet thick and range from white to dark smoky gray (Clark,

1970). Numerous lode gold mines developed on these veins have been operated intermittently since the 1860's. The Sheep Ranch mine, which produced \$7 million in gold, making it one of the most productive mines in the East Gold Belt, is less than a quarter-mile from the rancheria, and was developed to a depth of 3,000 feet. Ore contained free gold as well as varying amounts of sulfide minerals.

Near the Rancheria the "Superjacent Series" consists of Tertiary auriferous gravels and the Tertiary Valley Springs Formation. The auriferous gravels were deposited in Eocene and Miocene stream channels. They occur in isolated patches that are erosional remnants of the original channels, and in more extensive deposits covered by cappings of latitic volcanic rocks. The Eocene gravels, which contain the richest concentrations of placer gold are characterized by high concentrations of generally well cemented white quartz pebbles, cobbles, and boulders. Much of the gold is concentrated on the underlying bedrock surfaces. Later Tertiary gravels, known as "intervolcanic deposits" are characterized by less white quartz and abundant andesite and rhyolite clasts. These gravels are relatively lean in gold when compared with the Eocene channel deposits (Clark, 1970).

The Miocene Valley Springs Formation is above the auriferous gravels, and consists of flat-lying beds of white vitreous rhyolite tuff, pumice, and ash interbedded with gravel and breccia. The lower parts of the formation contain clay, silt, and sand (Clark and Lydon, 1962).

## Mineral Resources

Mineral resource potential is limited because the Sheep Ranch Rancheria encompasses less than 1 acre. There may be potential for gold production from gold-quartz veins in the bedrock units and from the Tertiary auriferous gravels. Base metals and silver would be potential by-products of lode-gold production. Rocks of the Calaveras Formation have potential for use as building stone. Mariposite associated with the serpentine is marketable as decorative stone. Also locally associated with serpentine are chromite pods and asbestos (chrysotile) which may have potential for development.

Sand, gravel, and clay might be produced from both the Tertiary gravel units and from the Valley Springs Formation. Pumice also occurs in the Valley Springs Formation and may have potential.

## SHINGLE SPRINGS RANCHERIA

### Location

The Shingle Springs Rancheria consists of 160 acres in the NW¼ sec. 29, T. 10 N., R. 10 E. in El Dorado County, approximately 5 miles southwest of Placerville, 2 miles northeast of the town of Shingle Springs, and 23 miles east of Sacramento (Figure 9). It lies at approximately 1,600 feet altitude in an area characterized by low rolling terrain cut by deeply incised streams. The rancheria is drained by several small, intermittent streams. Vegetation consists primarily of grass and oak trees. The land appears suitable for grazing.

Access to the rancheria is good over graded roads which lead from U.S. Highway 50, a four-lane major east-west thoroughfare that passes less than 1 mile to the south. The Southern Pacific railroad right-of-way is near the southern boundary. In 1976, there were no known permanent inhabitants of the rancheria. Land to the south and east is being developed for homesites.

### Geology

Extending through the area of the rancheria (Figure 9) is a north trending belt of pre-Cretaceous greenstone, green schist, slate, phyllite, metaconglomerate, and mafic pyroclastic rocks 4 to 6 miles wide (Lachenbruch, 1962). This belt of rocks has been intruded by numerous bodies of Mesozoic ultrabasic rocks including serpentine (in part, silicified), peridotite, dunite, olivine, pyroxenite, ankerite, talc schist, and amphibolite.

The southwest portion of the rancheria may contain other Mesozoic basic intrusives including medium- to coarse-grained hornblende gabbro, pyroxenite, noritic anorthosite, diorite, mafic porphyritic hypabyssal intrusive rocks and meta-gabbro (Matthews and Burnett, 1965).

### Mineral Resources

The rancheria is in the Shingle Springs mining district of the Sierra Nevada West Gold Belt. A belt of lode gold mines extends from the Pyramid mine, about 2.5 miles northwest of the rancheria, south to the vicinity of Brandon corner, a distance of about 10 miles. The district was first worked during the gold rush. The town of Shingle Springs

was settled in 1850. During the 1930's, there was considerable mining activity in the area (Clark, 1970, p. 117).

The land adjacent to the rancheria has been extensively prospected. However, no evidence of any mining activity in Indian land could be found. The nearest lode mines are the Pyramid (2.5 miles), the Shaw (1.3 miles), and the Greenstone (Barnes-Eureka) (0.9 miles). An area near the confluence of Slate and Dry Creeks, about  $\frac{3}{4}$  mile north of the rancheria, has been dredged.

The district's ore deposits consist chiefly of large, low-grade bodies of mineralized talcose amphibolite-chlorite-schist or greenstone containing numerous quartz veinlets and stringers. Disseminated auriferous pyrite occurs in both the wallrock and quartz veins and stringers. Some quartz veins have had high-grade pockets and abundant sulfides (Clark, 1970, p. 117).

The Pyramid (Gold Reserve) mine, active in the 1890's, is in secs. 12 and 13, T. 10 N., R. 9 E., 4 miles due north of the town of Shingle Springs. After lying idle for many years, it was reopened in 1933 and operated until 1939. Total gold production from the mine is approximately \$1,000,000 (Clark and Carlson, 1956, p. 423).

Country rock at the Pyramid mine consists of amphibolite schist between gabbro-diorite on the west and a band of serpentine on the east. The wall rocks contain ankerite and mariposite. The main quartz vein ranges from a few to as much as 20 inches thick, strikes northwest, and dips from 40° to 60° NE. The gold is associated with pyrite and smaller amounts of galena, arsenopyrite, and chalcopyrite. Development includes an 818-foot inclined shaft (Clark and Carlson, 1956, p. 423).

The Shaw (Shan Tsz, Volo), one of the better known gold mines in the West Gold Belt, is in sec. 21, T. 10 N., R. 10 E., 4 miles southwest of Placerville. It was active in the 1880's and again about 1915, 1940-1942, and 1946 to 1953. Starting in 1941, the mine was worked as an open pit.

The Shaw gold mine is in a body of quartzitic schist that lies in slate and schist of the Calaveras Formation. It is associated with pyrite, calcite, and talc. The ore is low-grade. Rich pockets of free gold have been found near the contact of the ore body and the surrounding country rock. The ore body strikes N. 10° E. and dips 85° SE. It averages about 100 feet in width and has been worked for about 1,000 feet along strike. Development consists of a 135-foot shaft, several crosscuts and drifts, and a large open trench.

The Greenstone (Barnes-Eureka) mine is in the NW $\frac{1}{4}$ NW $\frac{1}{4}$  sec. 33, T. 10 N., R. 10 E., about 2 miles northeast of Shingle Springs. It was worked prior to 1894, again in 1912, 1936, and from 1947 to 1949 (Clark and Carlson, 1956, p. 406). Total gold production is valued at approximately \$1,000,000 (Clark, 1970, p. 117). The gold is associated with arsenopyrite and tellurides in a 2-foot-thick quartz vein on the contact between serpentine on the east and fine-grained metavolcanic rocks on the west. The vein strikes north and dips 45° E. Development includes a 350-foot inclined shaft with levels at 100 and 200 feet, and a 250-foot shaft to the south (Clark and Carlson, 1956, p. 406).

The Expansion mine is about 1 mile north of the rancheria in the SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 17, T. 10 N., R. 10 E. It was active in 1900-1904, and again in 1936. Auriferous pyrite is disseminated in amphi-

bolite schist. Development includes a 150-foot crosscut adit (Clark and Carlson, 1956, p. 500).

El Dorado County has the largest known chromite deposits in the Sierra Nevada. Chromite has been produced west of the town of Shingle Springs, and from deposits about 2 miles north of the rancharia. Most production was during World War I. The chromite ore bodies are kidney-shaped masses, pods, or elongate lenses; they also occur as disseminated masses composed of closely-spaced spheroids and ellipsoids called "leopard ore." Chromite is found in ultramafic igneous rocks such as pyroxenite, peridotite, and dunite, or in serpentine derived from these rocks (Clark and Carlson, 1956, p. 385).

Serpentine on the rancharia may have potential for asbestos and soapstone. Most large serpentine bodies in El Dorado County are in the Shingle Springs-Latrobe area and have been the main source of soapstone mined in the county. Clark and Carlson (1956, p. 455) state that: "The soapstone deposits range from small lenses a few inches thick to those hundreds of feet in extent."

Slate and greenstone may have building stone potential if a local market should develop.

## **TUOLUMNE RANCHERIA**

### **Location**

The Tuolumne Rancharia is in sec. 32, T. 2 N., R. 16 E. and sec. 5, T. 1 N., R. 16 E., approximately 60 miles northeast of Modesto and 1 mile north of the town of Tuolumne in Tuolumne County (Figure 10). The rancharia, with an area of

about 323 acres of allotted land (U.S. Department of Commerce, 1974, p. 161), has a population of approximately 67. It is cut by several streams and has about 500 feet of relief. The site is on the lower western slope of the Sierra Nevada in an area of rolling uplands of moderate relief, cut by deeply incised canyons. Access is good over paved roads. Highway 49, about 10 miles to the west, is the nearest north-south route; Highway 108, 4 miles to the north, is the nearest east-west route.

### **Geology**

The vicinity of the rancharia is underlain primarily by Paleozoic metavolcanic and sedimentary rocks intruded by Jurassic-Cretaceous plutonic rocks (Figure 10). Most of the rancharia consists of metamorphic rocks of the Paleozoic Calaveras Formation including, (1) quartz-mica schist, (2) quartz, (3) phyllite, and (4) black slate (Clark, L. D., 1964; Clark, W. B., 1970). Minor amounts of thin-bedded metachert, metaconglomerate, and amphibolite schist may also be included. Limestone crops out south and west of the rancharia, and Tertiary andesites cap ridges to the north and west. The Jurassic-Cretaceous plutonic rocks which intrude the Calaveras Formation in this area are primarily granodiorites, although quartz-diorite and diorite also occur. Dioritic and aplitic dikes associated with gold-quartz veins cut both the granitic and metamorphic rocks.

The main "Mother Lode fissure system" consisting of eastward-dipping thrust and reverse faults intruded by gold-quartz veins lies about 10 miles west of the rancharia, although large amounts of ore were mined east of there in the

"East Gold Belt," an area which includes the Tuolumne Rancheria. A large number of unalined gold-quartz veins 1-5 feet thick occur in the vicinity surrounding the rancheria.

## Mineral Resources

The Tuolumne Rancheria is in the Soulsbyville district in the "East Gold Belt" of the Mother Lode. The area was intensely prospected during the late 1800's and early 1900's, and gold was produced from a number of lode mines adjacent to the rancheria.

The Soulsbyville district, the most productive area of the East Gold Belt, had a production of at least \$20 million. It was placer-mined during the gold rush, with lode mining beginning in the early 1850's. By 1915 most mines were idle. Some activity followed during the 1920's and 1930's, with very little prospecting since (Clark, 1970, p. 121).

The gold deposits occur in numerous randomly oriented gold-quartz veins in both granite and metamorphic rocks, and range from 1 to 5 feet in width. The ore bodies, commonly lenticular, contain native gold, as well as abundant sulfides, especially galena. Development reached a maximum depth of 1,500 feet (Clark, 1970, p. 121).

The Columbus mine is adjacent to the west boundary of the rancheria in secs. 31 and 32, T. 2 N., R. 16 E. The mine was worked intermittently prior to 1912 and again from 1933 to 1938 (Logan, 1948, p. 61). Production exceeded \$100,000. The gold-bearing quartz vein strikes N. 35° W. and dips 55° NE; country rock is primarily mica schist. A diorite porphyry dike is exposed on the hanging

wall. In 1914, development consisted of a 230-foot inclined shaft sunk on the vein with drifts north and south on the 100- and 200-foot levels (Tucker, 1915, p. 142).

The North Star and Laura mines are in the SW $\frac{1}{4}$ SW $\frac{1}{4}$  sec. 32, T. 2 N., R. 16 E. (Figure 10). The vein strikes N. 35° W., dips 50° NE., and has an average thickness of 5 feet. The quartz contains free-milling gold and small amounts of pyrite and galena. In 1914, development included the Laura shaft, 436 feet deep, and the North Star shaft, 400 feet deep (Tucker, 1915, p. 154).

The Cherokee mine (drift mine is about 1½) miles north of Tuolumne on a west ridge of Turnback Creek. The gold-bearing gravel channel runs northwest-southwest and is capped by a 400-foot-thick andesite flow. The underlying rock is decomposed granodiorite (Tucker, 1915, p. 166).

Several other producing gold mines, including the Ophir, Mammon, and Empire are east and northeast of the rancheria. Some area mines have reported lead as a by-product of the gold quartz ores. None, however, were worked only for their lead content (Logan, 1948, p. 75).

Little (1942, p. 283) describes nine scheelite occurrences which lie on the west slope of Mount Lewis about 1¾ miles south of Confidence and about 3 miles northeast of the rancheria. The scheelite occurs along the contacts between granitic rock and limestone roof pendants. No commercial production from these occurrences has been reported (Logan, 1948, p. 82).

## **GREAT VALLEY PROVINCE**

The Great Valley of California, which includes both the San Joaquin and Sacramento River valleys, lies between the Sierra Nevada to the east and the Coast Ranges on the west (Figure 11). It is an alluvial plain that extends 450 miles from the Tehachapi Mountains in the south to the Klamath Mountains in the north and is approximately 50 miles wide. Most of the valley is at an altitude of only several hundred feet, although locally some areas are as high as 1,000 feet. The valley has only one outlet, Carquinez Strait, through which the Sacramento River flows into San Francisco Bay. Part of the valley near the Carquinez Strait is below sea level, being protected from inundation by natural levees.

Geologically, the Great Valley is an elongate asymmetric structural trough which has filled with a thick sequence of sediments ranging in age from Jurassic to Recent. In the eastern half of the valley the sediments lie on a basement of metamorphic and plutonic rocks which are exposed in the Sierra Nevada foothills. Most of the sediments that fill the valley were derived from former elevated lands to the east and deposited in marine environments. Almost all of the rock types are clastic, including siltstone, claystone, and sandstone (Hackel, 1966). From Pleistocene to Recent time immense quantities of stream-born sediments from mountains surrounding the valley have been deposited in the form of river deposits and alluvial fans. The Kings River, which drains a portion of the Sierra Nevada, has formed a huge alluvial fan that projects across the Great Valley where it joins the Los Gatos Creek alluvial fan on the flanks of the Coast

Range. In the past, these fans cut off the southern portion of the San Joaquin Valley effectively creating Tulare Lake, which has been drained for agricultural land (Hackel, 1976).

## **SANTA ROSA RANCHERIA**

### **Location**

The Rancheria Santa Rosa, population 200, is in the San Joaquin Valley east of the Kings River approximately 30 miles south of Fresno and 20 miles west of Tulare, Kings County, in sec. 35, T. 19 S., R. 20 E., and contains 170 acres. Access to the rancheria is by secondary roads leading from (a) Highway 41, a north-south route 3 miles west of the reservation, (b) Highway 43, a north-south route 9 miles east of the rancheria, and (c) Highway 198, an east-west route which passes 4 miles north of the rancheria. Railroad junctions are in the nearby towns of Lemoore and Stratford, both of which are approximately 5 miles from the rancheria.

### **Geology**

The Santa Rosa Rancheria is underlain by permeable to moderately permeable Pleistocene to Recent Kings River alluvial fan deposits and basin-rim soils (Figure 12). Based upon well-log analysis, it is estimated that more than one-third of the sediments in the 10 to 50 foot-depth interval consist of sand and gravel (Davis and others, 1964). Many of the alluvial fan deposits on the western flanks of the Sierra Nevada contain high

proportions of clean, well-sorted sand and gravel deposited by the numerous perennial streams flowing into the San Joaquin Valley. Lateral shifting of streams has resulted in extensive coalescing fans. Alluvial fans are characterized by heterogeneous mixtures of coarse channel deposits and finer-grained flood deposits, and mean grain size generally decreases with increasing distance from the mountains.

The Sierra Nevada-derived fluvial deposits grade into and are interbedded with fine-grained lake and swamp deposits. The lake deposits consist of silt, clay, and well-sorted fine deltaic sands (Davis and others, 1964).

## Mineral Resources

Because of its location on the flat alluvial fan deposits of the Kings River delta, the rancheria has potential for sand, gravel, and perhaps, clay. However, much of the entire area has the same potential. Area farmers are reluctant to have their prime agricultural land defaced by gravel pits. Therefore, most of the sand and gravel used in the area has been imported from Fresno County (Jennings, 1953, p. 295).

The Kettleman Hills oil field, one of the largest producers in California, lies about 25 miles southwest. A number of exploratory wells have been drilled in the Hanford area, 10 miles to the east, and scattered wells have been drilled to the south, west, and north. In 1944, the Southern California Petroleum Corporation drilled an exploratory well (The Socal Bergan 88-32) to a depth of 10,478 feet in the SE $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 32, T. 19 S., R. 20 E., about three miles southeast of the rancheria. About 5

miles northeast of the rancheria, Humble Oil Company's "Capital Company G #1" well was drilled in 1961 to a depth of 12,816 feet in the E $\frac{1}{2}$ SW $\frac{1}{4}$  sec. 7, T. 19 S., R. 21 E. Both were abandoned (State of California Division of Oil and Gas, 1964, p. 259; Munger, 1972, map W40).

## MODOC PLATEAU PROVINCE

The Modoc Plateau Province lies north of the Sierra Nevada, west of the Basin and Range, and east of the Cascade Range in the northeast corner of the state (Figure 13). The region has an average altitude of 4,000 to 4,500 feet, but contains numerous higher ridges and peaks. The rocks are predominantly Tertiary volcanics which are interbedded with lacustrine and fluvial sediments.

Volcanic activity in this area has occurred as recently as a few hundred years ago. Faulting of the plateau occurred both during and after the volcanic activity and resulted in large areas of north- and northwest-trending scarp topography with individual scarps ranging from 200 to 400 feet high.

## ALTURAS RANCHERIA

### Location

The Alturas Rancheria, population about 9 (U.S. Department of Commerce, 1974, p. 79), is in Modoc County,  $\frac{1}{4}$  mile east of U.S. Highway 395 on the southeast side of the town of Alturas. It consists of 20 acres in the W SW $\frac{1}{4}$  sec. 18, T. 42

N., R. 12 E. The rancheria lies at an altitude of 4,300 feet in the flat land of the Pit River plain (Figure 14). The nearest railroad terminal is in Alturas.

## Geology

Nearly all of the Alturas Rancheria is underlain by unconsolidated sand, silt, and perhaps gravel and clay (Figure 14). Other basin deposits may include unconsolidated silt, clay, organic-rich marsh deposits, and thin layers of fine sand. Some alkali deposits may be present. The maximum thickness of the alluvial material is probably less than 100 feet (California Department of Water Resources, 1963).

Pliocene nonmarine deposits crop out near the rancheria and may occur on the rancheria under alluvium. These sediments are generally included in the Alturas Formation and include sandstone (some diatomaceous), siltstone, tuff, and shale.

## Mineral Resources

The alluvium underlying the rancheria may be a source of gravel, sand, clay, and perhaps diatomite and peat. However, the rancheria's location and small size are not favorable for the development of a commercial mining or quarrying operation. Numerous gravel pits are near the town of Alturas.

## LIKELY RANCHERIA

### Location

The Likely Indian Rancheria consists of 40 acres in the SE $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 21, T. 39 N., R. 13 E. in Modoc County, approximately 20 miles south of Alturas and 25 miles west of the Nevada border (Figure 15), and is between two forks of Warm Creek, a spring-fed perennial stream on the north flank of Tule Mountain. There are no permanent residents (U.S. Department of Commerce, 1974, p. 121). The altitude is about 4,700 feet. Access is by graded roads leading from Highway 395 which passes about 2 miles west. Southern Pacific Railroad tracks pass  $\frac{1}{2}$  mile to the south of the rancheria, but the nearest terminal is in Likely, about 5 miles away.

### Geology

The Geology of the Likely Rancheria area (Figure 15) consists largely of Tertiary nonmarine sediments overlain in part by alluvial fans. The Plio-Pleistocene nonmarine sediments are grouped into the Alturas Formation which consists of two nearly identical sedimentary members separated by a Plio-Pleistocene basalt member and the Warm Springs Tuff member. The lower sedimentary member is presumably underlain by volcanic and sedimentary rocks of the Miocene Cedarville Series and the Miocene Turner Creek Formation (California Department of Water Resources, 1963). The upper and lower members of the Alturas Formation have a total thickness of about 800 feet, and generally consist of relatively flat-lying tuff,

gravel, diatomaceous light-colored sandstone, diatomite, shale, sandstone, and siltstone (California Department of Water Resources, 1963).

The Warm Springs Tuff member which separates the upper and lower sedimentary members of the Alturas Formation is composed of Plio-Pleistocene pyroclastic rocks including 100 to 400 feet of gray to brown, massive pumice lapilli tuff, light colored ashy sandstone, welded tuff, and ash flow tuff (California Department of Water Resources, 1963).

Overlying the nonmarine sediments and the volcanic sediments and flows are alluvial fan deposits composed of generally stratified, poorly sorted gravel, sand, and silt. The finer grained sediments in the alluvial fan are generally those farthest from the flanks of the surrounding mountains. The northwest portion of the rancheria may be covered with rather fine grained alluvial silt and sand deposits.

## Mineral Resources

The mineral resource potential of the Likely Rancheria is low. Its small size and the general availability elsewhere of sand, gravel, stone, and volcanic construction materials are unfavorable factors for commercial development.

Several sand and gravel pits are within a 5-mile radius of the rancheria. Most are along the Likely-West Valley Reservoir road which passes about 2 miles north of the rancheria.

Peat has been produced about 1 mile west in sec. 20, T. 39 N., R. 13 E. (Sheridan and Berte, 1961, p. 4). The Jeffry peat deposit about 9 miles east, in Jess Valley, (sec. 12, T. 39 N., R. 14 E.)

was, during the early 1950's, the only commercial peat moss mining operation in California. The bog is free of tree and shrub growth and contains no alluvial material. The marketable peat extends 2 to 4 feet below the surface, and is underlain by a highly organic layer. The peat covers approximately 1,280 acres (Jennings, 1957, p. 406).

Mercury, sparsely disseminated in ribs of opalite, has been reported about 6 miles northeast in sec. 4, T. 39 N., R. 14 E. The occurrence has been exposed by short adits and trenches (U.S. Bureau of Mines, 1965, p. 199).

## LOOKOUT RANCHERIA

### Location

The Lookout Rancheria consists of 40 acres in the SW $\frac{1}{4}$ SE $\frac{1}{4}$  sec. 18, T. 39 N., R. 8 E., Modoc County. It is approximately 8 miles west of Adin and 11 miles by road from the nearest railroad facility at Nubieber ([Figure 16](#)). It is 2 miles east of the Pit River on the north flank of Pilot Butte at an altitude of approximately 4,100 feet, and is easily accessible by roads leading from Highways 139 and 299. There were 4 inhabitants in 1976.

### Geology

The major part of the rancheria ([Figure 16](#)) consists of Plio-Pleistocene lake deposits of the Bieber Formation including interbedded gravel, and black sand, silt, clay, and diatomite (California Department of Water Resources, 1963). The total thickness of these beds may exceed 1,000 feet, and

they are probably underlain by similar sediments of the Turner Creek Formation of Miocene age.

Pleistocene volcanic rocks which are well exposed in Pilot Butte immediately south of the rancheria may crop out on the rancheria. The dominant volcanic rock type is a dark colored olivine basalt which occurs in flows ranging in thickness from 50 to more than 200 feet. The basalts are typically jointed and faulted, and locally interbedded with beds of cinders, tuff, and mudflows.

The older lake deposits and volcanic rocks are in places overlain by alluvium which generally consists of unconsolidated silt and sand with occasional interbedded lenses of gravel and clay.

## Mineral Resources

The Winters gold district, about 9 miles north of the Rancheria, was first prospected in 1890. The vein at the Lost Cabin mine was discovered in 1904, and mining continued for a few years. The area was prospected again in the 1930's. Fine free gold, quartz, brecciated wallrock, calcite, and feldspar are found in several west- and northwest-striking veins. The deposits are shallow, and none have been developed to a depth greater than 300 feet (Clark, 1970, p. 177).

## SUSANVILLE RANCHERIA

### Location

The Susanville Rancheria is in the W $\frac{1}{2}$ E $\frac{1}{2}$ SW $\frac{1}{4}$  sec. 29, T. 30 N., R. 12 E., immedi-

ately north of the town of Susanville, in Lassen County (Figure 17) approximately 86 miles from Reno, Nevada. The rancheria consists of 30 acres and has an estimated population of 109 (U.S. Department of Commerce, 1974, p. 154). It is at an elevation of approximately 4,200 feet and is accessible from Highway 395, the main north-south route in the area, and from Highway 36, a secondary east-west route. The Southern Pacific railroad is less than 1 mile away.

The Susanville Rancheria is at the approximate juncture of three physiographic provinces: (1) the Sierra Nevada, (2) the Cascade Range, and (3) the Modoc Plateau (Figure 13). In this area, the physiographic boundaries are indefinite because of overlapping structures and rock types which generally characterize particular provinces. For example, block faulting that is characteristic of the Modoc Plateau extends into the Cascades, and characteristic rocks of the two provinces are intermingled (MacDonald, 1966). Rocks which are typical of the Cascades and the Modoc Plateau overlap the metamorphic and plutonic rocks which characterize the Sierra Nevada province that lies south of Susanville. The Cascade province, which lies west of Susanville is characterized by Eocene sedimentary rocks overlain by Pliocene to Recent volcanic rocks ranging in composition from olivine basalt to dacite. The Modoc region which lies north and east of Susanville consists of block-faulted ranges separated by valleys that are typically filled with "plateau" basalts, shield volcanoes, cinder cones, and lake deposits. The Modoc province can be thought of as part of the Basin and Range Province which has been flooded by volcanics probably related to coeval volcanic

activity in the Cascades (MacDonald, 1966). The rocks of the Modoc plateau range from Recent to perhaps Oligocene in age.

## Geology

Most of the Susanville Rancheria consists of Pleistocene basaltic volcanic rocks (Figure 17). These can occur as black to gray flows of aphanitic to medium-grained olivine basalts of variable thickness (generally 50-200 ft), andesitic basalt, pyroxene basalt, and local thick, interbedded mudflows (Lydon and others, 1960). Weathering of these basalts typically produces subrounded boulders in a red soil matrix. Locally, the Pleistocene basalts are broken by faulting, resulting in scarps from 10 to 100 feet in height. The basalt flows are commonly jointed and fractured.

Overlying the Pleistocene volcanic rocks are Pleistocene Lahontan Lake deposits which include bedded blue-gray silt, clay and sand interbedded with diatomite, ash, and lava flows (California Department of Water Resources, 1963). These deposits may be as much as several thousand feet thick. The lake bed deposits grade into near-shore deposits which consist of bedded, poorly consolidated gravel, sand, silt, and clay. The total thickness of these deposits near the basin margins is usually less than 300 feet, but they extend laterally beneath the lake bed deposits to the lowest points of the subsurface valley floor where their aggregate thickness may exceed several thousand feet.

Part of the rancheria may be covered by alluvial fan deposits which consist of stratified, generally poorly-sorted gravel, sand, and silt. Proximal parts of the alluvial fans, or those parts closest to

the mountains, are generally bouldery. Total thickness of such fans may be as much as 1,000 feet. The alluvial fans grade into alluvial plains that are composed of unconsolidated sand and silt with local gravel and clay lenses. This alluvium is probably all of Recent age and generally is less than 100 feet thick.

## Mineral Resources

The mineral resource potential of the Susanville Rancheria is low. The basalt and perhaps some alluvial fan deposits would be potential sources of crushed rock for road metal and aggregate.

Rhyolitic tuff has been quarried on the west edge of Susanville in sec. 31, T. 30 N., R. 12 E. Thousands of cubic yards of basalt have been removed from the Nolan quarry about 7 miles west of Susanville on the Red Bluff-Susanville highway for use as road metal. A quarry, developed in biotite-quartz diorite on the north slope of Gold Run Valley, is about 5 miles south of Susanville (Averill and Erwin, 1936, p. 443-444). Sand and gravel have been produced about ½ mile northwest of the reservation. Pumice has been quarried about 2 miles southeast of Susanville in sec. 10, T. 29 N., R. 12 E. (U.S. Bureau of Mines MILS files).

The Diamond Mountain gold mining district is about 5 miles south of Susanville in the Diamond Mountain block, at the extreme north end of the Sierra Nevada. Gold worth several hundred thousand dollars was recovered by placer mining in the late 1850's. Lode mining began in the 1860's and continued intermittently through the early 1900's. There was some renewed activity in the 1930's.

The total output of the district is estimated at about \$1 million (Clark, 1970, p. 43). Quartz diorite and granite, which is overlain in places by Tertiary gravels and andesite, underlie the district. Quartz veins up to 15 feet thick are present in shear zones, chiefly in the quartz diorite. The ore contains freemilling gold and pyrite. Milling ore is usually low- to medium-grade, but there are some high-grade pockets. The ore shoots tend to be small, and none of the mines has been developed to a great depth (Clark, 1970, p. 43).

## **XL RANCH RESERVATION**

### **Location**

The XL Ranch Reservation in Modoc County, consists of about 9,225 acres, which are divided into several geographically diverse parcels. The population totals about 29 (U.S. Department of Commerce, 1974, p. 165). Three parcels of land (referred to as area A) contain the majority of the XL Ranch acreage and are located approximately 4 miles northeast of Alturas (Figure 18). U.S. Highway 395 and Southern Pacific railroad tracks cross through the reservation along the valley of the North Fork of the Pit River. The junction of Highway 395 and Route 299 from Nevada is in the central part of the largest of these three parcels.

A relatively inaccessible tract (area B) containing approximately 160 acres in the E $\frac{1}{2}$ NE $\frac{1}{4}$  sec. 9, and N $\frac{1}{2}$ NW $\frac{1}{4}$  sec. 10, T. 43 N., R. 12 E., is 2 miles east of Big Sage Reservoir and approximately 7 miles north of Alturas (Figure 19).

A fifth tract of land (area C) is approximately 22 miles northwest of Alturas in sec. 36, T. 45 N., R. 9 E., and contains approximately 640 acres (Figure 20). This tract is also relatively inaccessible, with only unimproved roads and jeep trails.

Several tracts of land in the XL Ranch Reservation (area D) are in a strip along the west shore of Goose Lake about 20 miles north of Alturas (Figure 21). Access is by a light-duty improved road from Davis Creek, which is about 22 miles north of Alturas.

### **Geology**

The geology of area A of the XL Ranch Reservation (Figure 18) consists primarily of volcanic deposits interbedded with and overlain by fluvial and lacustrine sediments.

Rocks of the Cedarville Series of Miocene age crop out in the northwest parts of area A and include bedded tuff and tuff-breccia, with interbedded andesite and basalt. The Cedarville Series has been intruded by sills, plugs, and domes of younger Mio-Pliocene pale-colored, massive to jointed rhyolites which are associated with brown to black obsidian (California Department of Water Resources, 1963). A small patch of this rhyolite crops out near the Cedarville Series rocks in the northern portion of area A.

The Warm Springs Tuff member of the Plio-Pleistocene Alturas Formation crops out mainly along the west side of the Pit River valley and consists of from 100 to 400 feet of gray to brown, massive pumice lapilli tuff, light-colored ashly sandstone and welded tuff. The Warm Springs Tuff member is sandwiched by two very similar sedi-

mentary members that consist of generally flat-lying, light-colored sandstone, siltstone, gravel, diatomite, and tuff with a total thickness of perhaps 800 feet (California Department of Water Resources, 1963).

Plio-Pleistocene basalt crops out in the southern portions of area A and occurs as sloping plateaus. Individual flows range from 10 to 80 feet thick, are typically jointed and fractured, and are separated by scoria zones up to 20 feet thick. Locally, beds of clay, diatomite, and tuff are interbedded with the basalts.

On the northwest side of the reservation (area A) are extensive Pleistocene olivine basalt flows of the "Warner Basalt" (Gay and Aune, 1958). Individual flows range from 50 to 200 feet thick and are fractured, jointed, and faulted. Many of the fault-bounded blocks have been tilted resulting in topography characterized by steep scarps. Also cropping out in area A are Pliocene andesite, andesitic mudflows and tuff-breccia.

The volcanic rocks in area A are overlain by Pleistocene and Recent fluvial and lacustrine deposits. Lacustrine near-shore sediments deposited along beaches, terraces, and deltas include poorly consolidated gravel, sand, silt, and clay. Calcareous deposits may also be present as interbeds. The valley bottom areas and the reservation are generally covered with alluvium and fluvial deposits which consist of unconsolidated gravel, sand, silt, and clay.

Bedrock in reservation areas B (Figure 19) and C (Figure 20) consists wholly of Pleistocene olivine basalt of the "Warner Basalt."

Area D (Figure 21), along the west shore of Goose Lake, also is covered, especially in the

western parts, by the Pleistocene olivine basalts. Here they are cut by a series of northwest-trending normal faults (Gay and Aune, 1958). Pleistocene to Recent lake and stream terraces generally less than 50 feet thick occur on this part of the reservation and consist of poorly sorted gravel, sand, silt, and clay. Recent alluvial fan deposits consisting of generally poorly sorted, unconsolidated gravel, sand, and silt occur in the extreme northern portion of reservation area D.

Some low-lying parts of area D are covered with Recent alluvium, less than 100 feet thick which consists of unconsolidated sand, silt, gravel, and clay.

## Mineral Resources

The volcanic rock units on and adjacent to the XL ranch are potential sources of stone, scoria, pumice, pumicite, perlite, obsidian, sand, and gravel. The sedimentary units have potential for the production of gravel, sand, clay, dolomite, and stone. The stream deposits and terraces along the North Fork of the Pit River in area A are, in particular, potential sources of gravel.

Pumice was quarried about a quarter mile southeast of Surprise Station in secs. 11 and 14, T. 43 N., R. 13 E., about 7½ miles northeast of Alturas. Chesterman (1956, p. 29) refers to this quarry as the Weisman pumicite deposit. It was previously called the Foster volcanic sand pit by O'Brien (1948a, p. 351), who locates it on patented land in the SW¼NE¼, SE¼SW¼, SE¼ sec. 14, T. 43 N., R. 13 E., just outside the reservation boundary.

The Weisman deposit consists of poorly consolidated pumice lapilli tuff which was used primarily as an absorbent sand in the bottoms of cattle cars. Small amounts were used locally as plaster aggregate, and some was shipped to make pumice building blocks (Chesterman, 1956, p. 29; O'Brien, 1948a, p. 351). The pumice lapilli-tuff bed is flat-lying and extensive, but its actual thickness is unknown. The quarry is about 200 feet long, 100 feet wide, and 10 feet deep.

Goldman (1961, p. 25) describes a sand and gravel quarry in the SE $\frac{1}{4}$  sec. 5, T. 42 N., R. 13 E., about 2 miles northeast of Alturas and 1 mile southwest of the XL Ranch, in a stream terrace adjacent to the North Fork of the Pit River. The gravel lenses are irregular and consist of roughly 63 percent andesite-basalt, 33 percent rhyolite-dacite, 3 percent obsidian, and less than 1 percent tuff and quartz. The product is used as concrete sand and gravel, bituminous sand and gravel, and as road base.

Sand and gravel have been produced from the extreme southeast corner of the reservation in area D, near McGinty Point on Goose Lake.

Gold has been reported from a prospect in sec. 19, T. 43 N., R. 14 E.,  $\frac{1}{2}$  mile south of the road from Alturas to Cedarville, approximately 2 miles east of the XL Ranch. Development includes 2 shafts about 25 feet apart, in a shear zone in andesite, which follow irregular pods of quartz containing some sulfides (Averill, 1929, p. 16).

## THE BASIN AND RANGE PROVINCE

The Basin and Range province lies east of the Sierra Nevada and the Modoc Plateau, and consists of a series of north-trending ranges separated by broad alluviated valleys (Figure 22). This province extends as far east as Utah, and from Mexico to Oregon.

Four of the reservations in this study are in Owens Valley, Inyo County, Calif. From north to south, these are the Bishop, Big Pine, Fort Independence, and Lone Pine. Owens Valley is east of the crest of the Sierra Nevada at the western edge of the Basin and Range physiographic province. The Inyo Mountains of the Basin and Range Province lie east of the Big Pine, Fort Independence, and Lone Pine Reservations, and the White Mountains also of the Basin and Range Province are to the east of the Bishop Reservation.

Structurally, Owens Valley has an affinity with the Basin and Range province because it has formed over an elongate subsiding block which borders the Sierra Nevada to the west (Hinds, 1952). In this respect, it is similar to other valleys of the Basin and Range. Lithologically, however, the rocks underlying much of Owens Valley have an affinity with the Sierra Nevada, and the four reservations are underlain by alluvial detritus largely derived from the Sierra Nevada.

The Cedarville Rancheria and the Fort Bidwell Reservation are included in the Basin and Range physiographic province because of their structural setting. However, the volcanic and lacustrine lithologic units in this part of the province are the equivalents of formations in the Modoc Plateau Province.

## BIG PINE RESERVATION

### Location

The Big Pine Reservation consists of 279 acres in parts of secs. 17, 19, 20, T. 9 S., R. 34 E., at the southeast side of Big Pine, Inyo County, California (Figure 23). The population is approximately 50. Crossing its northeast corner is Big Pine Creek, which flows into the Owens River about 1 mile east of the reservation. The Big Pine Canal, which supplies water to the Los Angeles aqueduct, also crosses the northeast corner. Highway 395 provides access to the reservation.

### Geology

The Big Pine Reservation lies wholly on an undissected alluvial fan at the mouth of Big Pine Creek canyon (Figure 23). The age of the fan is mostly Holocene, but portions may be as old as Pleistocene (Bateman, 1965). The fan is derived from bedrock formations crossed by the Big Pine Creek drainage and from older dissected alluvial fans and lakebed deposits which lie immediately to the west. Downslope, near the Owens River, the alluvial fan grades imperceptibly into fine-grained alluvial fill which forms the valley bottom (Bateman, 1965).

The bedrock units underlying the reservation are not known, but may include basaltic lava flows which occur on the slopes of Crater Mountain which lies less than one mile south of the reservation boundary.

## Mineral Resources

There are several small gold mines and prospects in the Fish Springs or Tinemaha district, about 8 miles south of Big Pine. The deposits generally consist of a series of narrow, parallel gold-quartz veins in granitic rocks that are commonly associated with diorite dikes (Clark, 1970, p. 149).

Tungsten deposits occur west and northwest of the town of Big Pine. There are numerous mine workings along the canyon of Big Pine Creek in the mountains to the west (Norman and Stewart, 1951, Plate I). It is possible that scheelite and gold may have been washed down the creek as far as the reservation.

Except for possible sand and gravel resources, the mineral potential is low. The land is currently being used primarily for homesites; some is suitable for pasture and agriculture.

## BISHOP RESERVATION

### Location

The Bishop Reservation (Paiute-Shoshone Indian Reservation) consists of 875 acres, but only 90 are tribally owned (U.S. Department of Commerce, 1974, p. 87). The land is in parts of secs. 1, 2, and 11, T. 7 S., R. 32 E., immediately west of Bishop, California (Figure 24). Leading south from U.S. Highway 395, paved and unpaved roads cross the area at quarter-mile and half-mile intervals. The population is approximately 500, and homes have been built along all the aforementioned roads.

The North and South Forks of Bishop Creek cross the reservation, and the Owens River Canal, a part of the Los Angeles aqueduct, is just to the west.

## Geology

The Bishop Indian Reservation, like the Big Pine Reservation, lies entirely on an undissected younger alluvial fan, Holocene to Pleistocene in age (Figure 24). This fan has formed at the mouth of Bishop Creek and at the distal portions, grades into alluvial fill. The fan is distinguished from the alluvial fill of the valley by being coarser and more poorly sorted (Bateman, 1965).

Approximately one mile south of the southern boundary of the reservation lies a series of dissected alluvial fan and lakebed deposits which are most likely Pleistocene, but may be as old as Pliocene. These older fans have formed on top of Cretaceous quartz monzonites similar to the Cathedral Peak granite. Between the older fans and the quartz monzonite are Paleozoic and Mesozoic sedimentary rocks, which were intruded by the quartz monzonite, and were metamorphosed into marble, calc-hornfels, pelitic hornfels, and quartzite (Bateman, 1965). These rocks are favorable hosts for ore minerals, and 2½ miles south of the reservation, where these metasedimentary rocks crop out, there has been profitable mining. Within several miles of the reservation are the Rossi Tungsten mine, Bishop Antimony mine, Yaney mine, Brown prospect, Early Morhardt prospect, and the Chipmunk mine. Each of the five tungsten mines in this group has produced more than 100 units of  $WO_3$  (Bateman, 1965).

Tungsten mining began in the Bishop vicinity about 1916, and production peaked during World War II. During the Korean War, there was a renewal of tungsten mining, but this ceased in the mid-1950's. Prior to the tungsten mining, other mines in the district produced gold and molybdenum.

Five miles west of the reservation are the Tungsten Hills. The intrusion of another Cretaceous pluton, the Tungsten Hills quartz monzonite into Paleozoic and Mesozoic sedimentary rocks resulted in tungsten mineralization here. This area was intensively mined from World War I to the mid-1950's but is now inactive.

## Mineral Resources

The alluvial fan deposits on the reservation may be a source of gravel and sand. There is a slight possibility for placer deposits of scheelite or gold.

## FORT INDEPENDENCE INDIAN RESERVATION

### Location

The Fort Independence Indian Reservation is on U.S. Highway 395 about 2 miles north-northeast of Independence (Figure 25). It is in sec. 1, T. 13 S., R. 34 E., and in sec. 6, T. 13 S., R. 35 E., contains 234 acres of tribally-owned land and 122 acres of allotted land, and has a population of 62 (U.S. Department of Commerce, 1974, p. 105). There are many unpaved roads and one paved road

leading from U.S. Highway 395. A branch of Oak Creek flows through the central part of the area. The Los Angeles aqueduct is approximately 1 mile east of the reservation.

## Geology

The northwest part of the Fort Independence Indian Reservation lies on undissected alluvial fan deposits at the mouth of Oak Creek (Figure 25). The alluvial fans which consist of unconsolidated, poorly sorted gravel, sand, silt, and clay grade into finer grained alluvial fill deposits of silt and fine sands which cover the floor of Owens Valley (Ross, 1965).

## Mineral Resources

The chief mineral potential for the reservation lies in the possible development of sand and gravel pits, several of which already exist within a few miles of the reservation boundaries. No mineral deposits are close enough to the reservation to warrant projection of mineralized zones.

Most of the land is being used for homesites.

The Owens River is approximately 1 mile east of the reservation.

## Geology

The major portion of the Lone Pine Reservation (Figure 26) consists of unconsolidated Sierra-derived alluvial fan deposits of Lone Pine Creek, parts of which may be coarse grained. The eastern part of the reservation consists of unconsolidated, generally finer grained lacustrine and fluvial sand, silt, and clay (Matthews and Burnett, 1965; Ross, 1965).

## Mineral Resources

The surficial deposits may have potential as sources of gravel, sand, and clay. According to Goldman (1961, p. 34), alluvial fan deposits in the vicinity of Lone Pine are at least 20 feet deep. Where commercial deposits have been developed, they contain about 70 percent sand and 30 percent gravel.

## CEDARVILLE RANCHERIA

### LONE PINE RESERVATION

#### Location

The Lone Pine Reservation contains approximately 237 acres in secs. 27 and 28, T. 15 S., R. 36 E., Inyo County, and has a population of about 160. A number of unpaved roads leading from U.S. Highway 395 provide access to the numerous

#### Location

The Cedarville Rancheria, population 7, contains 17 acres in sec. 7, T. 42 N., R. 16 E., on the west side of Cedarville, population 800. Cedarville is in Modoc County on Highway 299, approximately 2 miles west of Middle Alkali Lake and 9 miles west of the Nevada border, and lies at the foot of the Warner Range at an altitude of approxi-

mately 4,700 feet. The nearest railroad center is in Alturas, about 20 miles west.

## Geology

The Oligocene Deep Creek Conglomerate crops out west of the rancharia (Figure 27) and along the foot of the Warner Mountains north and south of the rancharia. It consists of westward-dipping beds of massive, consolidated conglomerate with interbedded shale, mudflows, and tuff (California Department of Water Resources, 1963), and is overlain by Pleistocene near-shore lake deposits which may be Lahontan Lake deposits. These include poorly consolidated gravel, sand, silt, and clay with interbedded lava flows, diatomite, and volcanic ash.

Both the Deep Creek Conglomerate and the Pleistocene lake deposits are overlain by Recent alluvial fan deposits of interbedded gravel, sand, silt, and possibly clay. The clastic debris in the fans has weathered from older units that include volcanics of the Miocene Cedarville series which forms the crest of the Warner Mountains. Clasts from the Cedarville Series include tuff, tuff breccia, basalt, andesite, and rhyolite.

## Mineral Resources

The near-shore lake deposits and the alluvial fan deposits nearby are sources of gravel, sand, and clay. The lake deposits may contain diatomite. There is a gravel pit in the NW $\frac{1}{4}$ NE $\frac{1}{4}$  sec. 7, T. 42 N., R. 16 E., just west of the rancharia, and several others are near the main highway north of Cedarville.

## FORT BIDWELL RESERVATION

### Location

The Fort Bidwell Reservation at the north end of Surprise Valley is immediately west of the town of Fort Bidwell, population 100, in the northeast corner of the state, about 8 miles from Nevada and Oregon. The reservation, population 163, is in Modoc County in secs. 1, 12, 13, and 24, T. 46 N., R. 15 E., and in secs. 7, 17, 18, 19, and 20, T. 46 N., R. 16 E., and consists of approximately 3,335 acres. Access is from roads which lead north from Highway 299 at Cedarville.

The reservation is in an area of rugged topography and fairly high relief, ranging in altitude from 4,500 feet on the valley floor to over 7,000 feet on the west. Several perennial streams crossing the reservation have cut steep-walled canyons.

### Geology

The geologic units which occur in the Fort Bidwell Reservation include (Figure 28), (1) Tertiary volcanic rocks, and (2) Pleistocene lake deposits.

The stratigraphically lowest outcropping unit is the Cedarville Series of Miocene age which consists of up to 7,500 feet of bedded tuff, tuff breccia, basalt, and andesite flows intruded by younger sills of rhyolite (California Department of Water Resources, 1963). Above the Cedarville Series are Miocene pyroclastic rocks which may be correlative with the Turner Creek Formation, also of Miocene age. The pyroclastics consist primarily of

dark colored mudflows and pale-colored tuff with local beds of sandstone and diatomite.

Miocene basalts are the highest unit stratigraphically and form the highest ridges on the west side of the reservation. These dark-colored olivine basalts, as much as several hundred feet thick, are interbedded with scoria. The flows are typically fractured and are cut by normal faults of large displacement.

Lake deposits, alluvial fans, and alluvium occur on the eastern lower portions of the reservation. Pleistocene near-shore lake deposits overlap the Cedarville Series and the Miocene pyroclastic rocks, and consist of poorly consolidated gravel, sand, silt and clay (California Department of Water Resources, 1963). Generally these deposits are less than 300 feet thick, but they may be as thick as several thousand feet under the valley floor. Alluvial fans cover the easternmost areas of the reservation and consist of unconsolidated, poorly sorted gravel, sand, and silt. Recent alluvium consists of unconsolidated sand, and silt with some lenses of gravel and clay.

The northern part of the reservation may include small areas of Tertiary intrusive rhyolite sills, dikes, and plugs.

## Mineral Resources

The High Grade gold mining district which has probably yielded several hundred thousand dollars worth of gold (Clark, 1970, p. 149), lies about 6 miles north of the reservation. The discovery date of gold in the district is unknown. However, some 1880 to 1885 Modoc County gold production may have come from here. Gold was rediscovered by a

sheepherder in 1905 and mining resumed and lasted for several years. Intermittent prospecting and development continued through the 1920's and 1930's, but no significant discoveries were made.

Hill (1915, p. 43) classifies the ore deposits of the High Grade district into three distinct types: (1) veins in granular rhyolite with some wallrock replacement; (2) veins in andesite; and (3) veins and replacement in glassy rhyolite. The first type deposit is the most important. The vein material consists of quartz, silicified and brecciated country rock, and fault gouge. The ore contains fine gold, some silver alloyed with the gold, finely divided pyrite, and manganese-stained material. Minor amounts of copper are in some andesite veins. All the deposits are shallow and have been developed to only a few hundred feet in depth (Hill, 1915, p. 43; Clark, 1970, p. 149).

Hill (1915, p. 47-48) concluded that, although some of the deposits in the High Grade district were rich, they were in narrow veins and shallow. He believed that any deposits found at depth would probably be low-grade and not economic to mine.

Copper has been reported 7 miles south at the Seitz mine, where it is found in a series of narrow veins in andesite which carries opalite, malachite, azurite, and native copper. Some ore has been shipped (Averill, 1936, p. 451).

Numerous gravel pits are in the alluvial deposits in Surprise Valley east of Fort Bidwell. Similar deposits in the lower eastern parts of the reservation may contain gravel, sand, and clay.

Waring (1965, p. 20) reports a hot spring near Bidwell Creek, about 1 mile northwest of Fort Bidwell. Five springs, having a water temperature of 97 to 100°F, and a flow of 75 gallons per min-

ute, issue from faulted lava rock. The water is used for domestic supply, irrigation, and bathing. The 15-minute topographic map of the Fort Bidwell quadrangle shows a hot spring on Soldier Creek, on the reservation, just west of the town of Fort Bidwell. No information could be found concerning this spring.

## **CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER WORK**

Except for the Tule River, XL Ranch, and Fort Bidwell Reservations, the Indian lands discussed herein are generally too small to support large mining operations. Almost all have potential for sand and gravel, which could be quarried for local use where other sources are not available nearby. Portions of most reservations and rancherias that are not being used for homesites, pasture, or agricultural purposes would be suitable for small sand and gravel quarries.

The Shingle Springs, Jackson, Sheep Ranch, and Tuolumne Rancherias are in the Mother Lode East Gold Belt and may have potential for gold and associated metals such as silver, copper, and zinc. The areas adjacent to the rancherias have been heavily prospected in the past, and any gold present is probably at great depth.

The Tule River Indian Reservation has potential for tungsten, dolomite, limestone, stone, and perhaps gold. The extent of the mineralized zones and the geologic relationships among the rock units, however, are poorly known. Detailed geologic mapping, with special emphasis on the

contacts between the granitic intrusives and the metasedimentary rocks, is needed. Stream sediment geochemical sampling would be useful in determining the location of mineralized areas. Soil sampling could further define the extent of the mineralized zones.

The Fort Bidwell Reservation may have potential for gold and copper. It contains several of the same rock types as are present in the High Grade gold mining district, 6 miles to the north. Geochemical stream sediment sampling might indicate the presence of any mineralized areas on the reservation.

## REFERENCES

- Albers, J. P., 1966, Mineral resources of California; California Div. Mines and Geology Bull. 191, 450 p.
- Averill, C. V., 1929, Modoc County, in Report XXV of the State Mineralogist: Calif. Div. Mines, v. 25, no. 1, p. 10-19.
- \_\_\_\_\_, 1936, Mineral resources of Modoc County: Calif. Jour. Mines and Geol., v. 32, no. 4, p. 445-457.
- Averill, C. V., and Erwin, H. D., 1936, Mineral resources of Lassen County: Calif. Jour. Mines and Geol., v. 32, no. 4, p. 405-444.
- Bateman, P. C., 1965, Geology and tungsten mineralization of the Bishop district, California: U.S. Geol. Survey Prof. Paper 470, 208 p.
- Bateman, P. C., and Wahrhaftig, Clyde, 1966, Geology of the Sierra Nevada, in Bailey, E. H., ed., 1966, Geology of northern California: California Div. Mines and Geology Bull. 190, p. 107-172.
- Bowen, Oliver E., 1973, Limestone and dolomite resources of California: California Div. Mines and Geology Bull. 194, 60 p.
- Burnett, J. L., and Jennings, C. W., 1962, Geologic map of California Chico sheet: California Div. Mines and Geology Map Sheet, scale 1:250,000.
- California Department of Water Resources, 1960, Investigation of Upper Feather River Basin Development: California Dept. Water Resources Bull. 59-2, 333 p.
- \_\_\_\_\_, 1963, Northeastern counties ground water investigation: California Dept. Water Resources Bull. 98, 223 p.
- Carlson, D. W., and Clark, W. B., 1954, Mines and mineral resources of Amador County, California: Calif. Jour. Mines and Geol., v. 50, no. 1, p. 149-285.
- Carr, D. D., and Rooney, L. F., 1975, Limestone and dolomite, in Lefond, Stanley J., ed., Industrial Minerals and Rocks, 4th ed., AIME, p. 757-789.
- Chesterman, C. W., 1956, Pumice, pumicite, and volcanic cinders in California: California Div. Mines and Geology Bull. 174, 119 p.
- Clark, L. D., 1964, Stratigraphy and structure of part of the western Sierra Nevada metamorphic belt, California: U.S. Geol. Survey Prof. Paper 410, 70 p.
- Clark, W. B., 1970, Gold districts of California: California Div. Mines and Geology Bull. 193, 186 p.
- Clark, W. B., and Carlson, D. W., 1956, Mines and mineral resources of El Dorado County, California: Calif. Journal Mines and Geol., v. 52, no. 4, p. 369-591.
- Clark, W. B., and Lydon, P. A., 1962, Mines and mineral resources of Calaveras County, California: California Div. Mines and Geology County Rept. 2, 217 p.
- Compton, R. R., 1955, Trondhjemite batholith near Bidwell Bar, California: Geol. Soc. America Bull., v. 66, p. 9-44.
- Davis, L. E., Branner, G. C., and Ashizawa, R. Y., 1958, The mineral industry of California: U.S. Bur. Mines Miner. Yearbook 1956, v. III - Area Repts., p. 167-246.

- Davis, G. H., Lofgren, B. E., and Mack, Seymour, 1964, Use of ground-water reservoirs for storage of surface water in the San Joaquin Valley, California: U.S. Geol. Survey Water-Supply Paper 1618, 125 p.
- Franke, H. A., 1930, Tulare County, in Report XXVI of the State Mineralogist: California Div. Mines Rept. 26, no. 4, p. 423-471.
- Gay, T. E., Jr., and Aune, Q. A., 1958, Geologic map of California, Alturas sheet: California Div. Mines and Geology Map Sheet, scale 1:250,000.
- Goldman, H. B., 1961, Sand and gravel in California, an inventory of deposits; Part A--Northern California: California Div. Mines Bull. 180-A, 38 p.
- \_\_\_\_\_, 1964, Sand and gravel in California, an inventory of deposits; Part B--Central California: California Div. Mines and Geology Bull. 180-B, 58 p.
- \_\_\_\_\_, 1966, Sand and gravel, stone, crushed and broken, and stone, dimension, in Albers, J. P., ed., 1966, Mineral resources of California: California Div. Mines and Geology Bull. 191, p. 361-374, 392-408.
- Goodwin, J. G., 1958, Mines and mineral resources of Tulare County, California: Calif. Jour. Mines and Geol., V. 54, p. 317-492.
- Hackel, Otto, 1966, Summary of the geology of the Great Valley, in Bailey, E. H., ed., 1966, Geology of northern California: California Div. Mines and Geology Bull. 190, p. 217-238.
- Hill, J. M., 1915, High Grade district, Modoc County, California, in Some mining districts in northeastern California and northwestern Nevada: U.S. Geol. Survey Bull. 594, p. 38-48.
- Hinds, N. E., 1952, Evolution of the California landscape: California Div. Mines and Geology Bull. 158, 240 p.
- Jenkins, O. P., 1942, Tabulation of tungsten deposits of California to accompany economic mineral map No. 4: Calif. Jour. Mines and Geol., v. 38, nos. 3 and 4, p. 303-364.
- Jennings, C. W., 1953, Mines and mineral resources of Kings County, California: Calif. Jour. Mines and Geol., v. 49, no. 3, p. 273-296.
- \_\_\_\_\_, 1957, Peat, in Mineral Commodities of California: California Div. Mines Bull. 176, p. 403-408.
- \_\_\_\_\_, 1966, Peat, in Mineral and water resources of California, Part I--mineral resources: California Div. Mines and Geology Bull. 191, p. 288-291.
- Kerr, P. F., 1946, Tungsten mineralization in the United States: Geol. Soc. America Mem. 15, 241 p.
- Kleinfelder, J. H., and Associates, 1977, Geologic investigation of a dolomite deposit on the Tule River Indian Reservation: Unpub. Rept., 45 p.
- Krauskopf, K. B., 1953, Tungsten deposits of Madera, Fresno, and Tulare Counties, California: Calif. Div. Mines Spec. Rept. 35, 83 p.
- Lachenbruch, M. C., 1962, Geology of the west side of the Sacramento Valley, California, in Geologic guide to the gas and oil fields of northern California: California Div. Mines and Geology Bull. 181, p. 53-66.
- Laizure, C. McK., 1922, Tulare County, in Report XVIII of the State Mineralogist: Calif. State Min. Bur., v. 18, no. 10, p. 519-538.

- Little, J. M., 1942, Tungsten deposits of the Confidence mining district, Tuolumne County, California; Calif. Jour. Mines and Geol., v. 38, nos. 3 and 4, p. 283-290.
- Logan, C. A., 1934, Mother Lode Gold Belt of California: California Div. Mines Bull. 108, 240 p.
- \_\_\_\_\_, 1948, Mines and mineral resources of Tuolumne County, California: Calif. Jour. Mines and Geol., v. 49, no. 1, p. 47-83.
- Logan, C. A., Braun, L. T., and Vernon, J. W., 1951, Mines and mineral resources of Fresno County, California: Calif. Jour. Mines and Geol., v. 47, no. 3, p. 485-552.
- Lydon, P. A., Gay, T. E., and Jennings, C. W., 1960, Geologic map of California, Westwood sheet (Susanville): California Div. Mines and Geology Map Sheet, scale 1:250,000.
- MacDonald, G. A., 1966, Geology of the Cascade Range and Modoc Plateau, in Bailey, E. H., 1966, Geology of northern California: California Div. Mines and Geology Bull. 190, p. 65-96.
- Matthews, R. A., and Burnett, J. L., 1965, Geologic map of California, Fresno sheet: California Div. Mines and Geology Map Sheet, scale 1:250,000.
- Munger, A. H., 1972, California oil and gas fields: Munger Map Book, 16th ed., map W40.
- Norman, L. A., Jr., and Stewart, R. M., 1951, Mines and mineral resources of Inyo County, California: Calif. Jour. Mines and Geol., v. 47, no. 1, p. 17-23.
- O'Brien, J. C., 1948a, Modoc County, in Current and recent mining activities in the Redding district: Calif. Jour. Mines and Geol., v. 44, no. 4, p. 349-354.
- \_\_\_\_\_, 1948b, Mines and mineral resources of Butte County, California: Calif. Jour. Mines and Geol., v. 45, no. 3, p. 417-454.
- Rogers, T. H., 1966, Geologic map of California, San Jose sheet: California Div. Mines and Geology Map Sheet, scale 1:250,000.
- Ross, D. C., 1965, Geology of the Independence quadrangle, Inyo County, California: U.S. Geol. Survey Bull. 1181-0, 42, scale 1:62,500.
- Sheridan, E. T., and Berte, V. C., 1961, Peat producers in the United States in 1960: U.S. Bur. Mines Inf. Circ. 8041, 11 p.
- Smith, A. R., 1964, Geologic map of California, Bakersfield sheet: Calif. Div. Mines and Geology Map Sheet, scale 1:250,000.
- State of California, Division of Oil and Gas, 1964, Exploratory wells drilled outside of oil and gas fields in California to December 31, 1963, 320 p.
- Strand, R. G., and Koenig, J. B., 1965, Geologic map of California, Sacramento sheet: California Div. Mines and Geology Map Sheet, scale 1:250,000.
- Tucker, W. B., 1915, Tuolumne County, in Mines and mineral resources of Amador County, Calaveras County, and Tuolumne County: Calif. State Min. Bur. Rept. 14, p. 132-180.
- \_\_\_\_\_, 1917, Mines and mineral resources of San Bernardino and Tulare Counties: Calif. State Min. Bur. Rept. 15, p. 126-186.

- U.S. Bureau of Mines Staff, 1965, Mercury potential of the United States: U.S. Bur. Mines Inf. Circ. 8252, 376 p.
- U.S. Department of Commerce, 1974, Federal and State Indian Reservations and Indian Trust Areas: U.S. Govt. Printing Office, Washington, 604 p.
- Wallace, R. E., McLenegan, J. D., and Matson, E. J., 1957, The mineral industry of California: U.S. Bur. Mines Miner. Yearbook 1954, v. III - Area Repts., p. 157-246.
- Waring, G. A., 1965, Thermal springs of the United States and other countries of the world--a summary: U.S. Geol. Survey Prof. Paper 492, 383 p.
- Wicken, O. M., and Duncan, L. R., 1975, Magnesite and related minerals, in Lefond, Stanley J., ed., Industrial Minerals and Rocks, 4th ed., AIME, p. 805-820.
- Wright, L. A., ed., 1957, Mineral commodities of California, geologic occurrence, economic development and utilization of the state's mineral resources: California Div. Mines and Geology Bull. 176, 736 p.

Table 2.--Specifications for limestone, dolomite, and lime for the principal consuming industries 1/

(Reprinted from Bowen, 1973, p. 43-44)

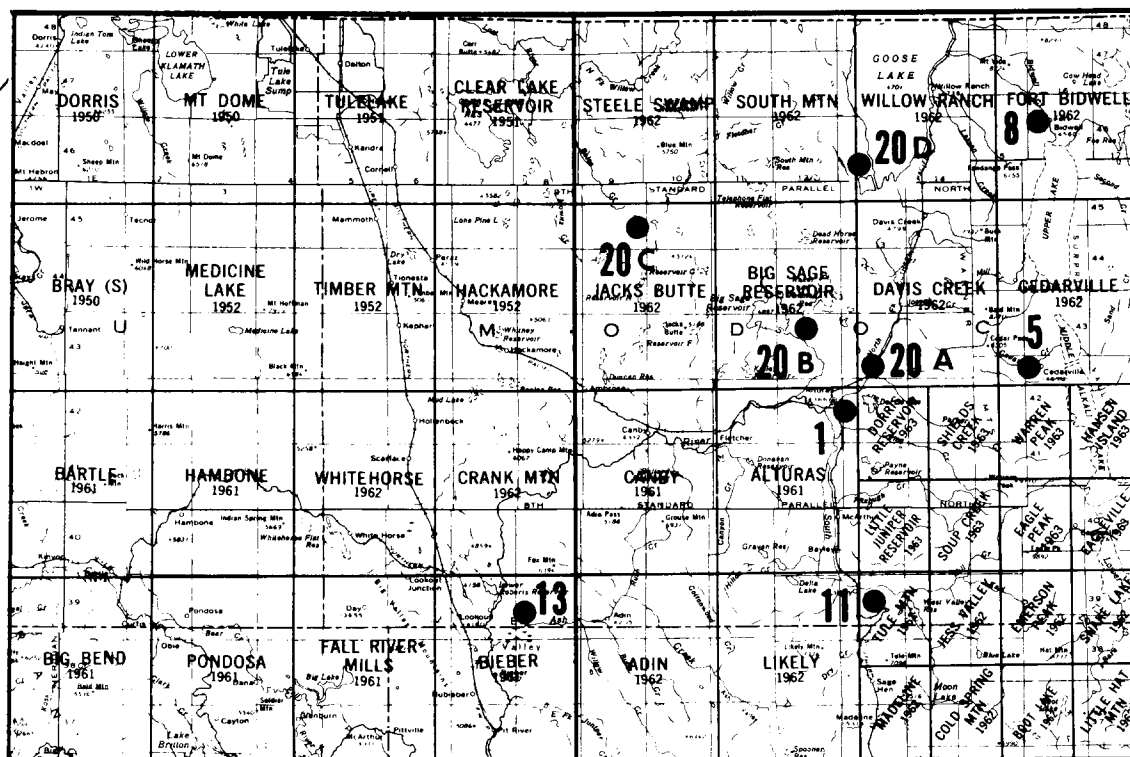
Use	Chemical Requirements	Physical Requirements
Limestone for portland cement	Magnesium oxide (MgO) not more than 3%, preferably not more than 2%. Total alkalis not more than 0.5%. Minimum calcium carbonate ( $\text{CaCO}_3$ ) content varies from plant to plant depending upon availability of raw materials, but generally is more than 82%.	Some manufacturers prefer limestone that does not decrepitate during calcining, i.e., that will hold its lump shape throughout calcination.
Limestone for lime (high calcium)	Calcium carbonate ( $\text{CaCO}_3$ ) content not less than 97%, preferably 98% or more.	Some manufacturers prefer rock that does not decrepitate during calcining.
Magnesian limestone for lime (magnesian)	Magnesium oxide (MgO) content should fall between the limits of 10 and 15%, preferably 11-12%.	Some manufacturers specify rock that will not decrepitate when heated.
Limestone and magnesian limestone for steel flux (blast furnaces)	Silica ( $\text{SiO}_2$ ) less than 5%, less than 2% preferred. Alumina ( $\text{Al}_2\text{O}_3$ ) less than 2%. Magnesia (MgO) less than 4% to less than 0.15% at various plants. Phosphorus pentoxide ( $\text{P}_2\text{O}_5$ ) not more than a trace, i.e., 0.005 to 0.006.	Some manufacturers specify rock that holds its lump form until consumed in the melt.
Limestone for steel flux (open hearth)	Calcium carbonate content preferably not less than 96%, lower grades occasionally accepted. Phosphorus must not exceed trace amounts.	
Dolomite for refractories	Magnesium oxide (MgO) not less than 18%. Silica ( $\text{SiO}_2$ ), ferric oxide ( $\text{Fe}_2\text{O}_3$ ) and alumina ( $\text{Al}_2\text{O}_3$ ) not to exceed 1% each, but lower grades sometimes accepted.	Some manufacturers require rock that will not leave a scum when dissolved in acid.
Limestone for general chemical use	Calcium carbonate content should not exceed 98%. Preferred rock runs more than 99% $\text{CaCO}_3$ . Limestone as low as 97% $\text{CaCO}_3$ is sometimes accepted.	
Limestone for beet-sugar manufacturers	Silica ( $\text{SiO}_2$ ) not more than 1%. Magnesia not more than 4%. At some plants ferric oxide ( $\text{Fe}_2\text{O}_3$ ) must not exceed 0.5%.	To be acceptable at most California plants limestone must retain its lump form during calcination (burning).
Agricultural limestone	In general the higher the lime (CaO) content the better the price. Rock containing less than 85% $\text{CaCO}_3$ is seldom accepted.	Other factors being equal, a soft friable rock is more acceptable because it is cheaper to process.
Agricultural dolomite	The price received is dependent mainly on the calcium-magnesium carbonate content, rocks being seldom accepted if they contain less than 85% of carbonate minerals.	Same as agricultural limestone.
Limestone and dolomite for glass	Ferric oxide ( $\text{Fe}_2\text{O}_3$ ) not more than 0.05%, preferably not more than 0.02% for colorless glass, rock having up to 0.1% $\text{Fe}_2\text{O}_3$ is sometimes accepted for colored container glass. Calcium carbonate ( $\text{CaCO}_3$ ) should exceed 98% in case of limestone, or 98% calcium-magnesium carbonate in case of dolomite. Amounts of silica, alumina, magnesia etc., must not vary from shipment to shipment.	Some plants specify rock having a low decrepitation factor.
Limestone for calcium carbide and calcium cyanamide	Calcium carbonate ( $\text{CaCO}_3$ ) content must exceed 97% and should exceed 98%. Magnesium oxide (MgO) should be less than 0.5%; alumina and ferric oxides (together) less than 0.5%; silica ( $\text{SiO}_2$ ) less than 1.2; and phosphorus less than 0.01%. Sulfur must not be present in greater than trace amounts.	Rock must retain its lump form during calcination.
Limestone for paint and filler	In general the calcium carbonate content should exceed 96% but magnesian limestones containing as much as 8% magnesium oxide occasionally are tolerated--the $\text{MgCO}_3$ content generally is 1%. Other maxima are: $\text{Fe}_2\text{O}_3$ --0.25%, $\text{SiO}_2$ --2.0%, and $\text{SO}_2$ --0.1%.	Rock which breaks down into rhombic particles is preferred in some plants. The main controlling characteristic is the degree of whiteness shown by the processed material.
Limestone and dolomite for concrete aggregate, ballast, road metal, road base	Concrete aggregate should be low in alkalis and free from surface organic matter. Presence of opaline silica is highly undesirable in concrete aggregate. Other aggregate suitability is based chiefly on durability, particularly toughness.	Must be clean, strong, durable, and of low porosity.
Quicklime for pulp and paper manufacturers	Calcium carbonate ( $\text{CaCO}_3$ ) contents must be more than 96% for most manufacturers.	Must be thoroughly hydrated, fine grained and free of grit.
Lime for soft rubber goods	Magnesian lime is generally used. Must be free from carbonates and should contain less than 3% of total impurities other than carbon dioxide or magnesium oxide. In vulcanization such lime must also be free of manganese, copper, and calcium oxides.	
Lime for lubricants (greases)	Calcium oxide not less than 72.6%, magnesium oxide not more than 1%, maximum silica plus iron plus alumina, 1.5%, maximum carbon dioxide (at point of manufacture) 1%.	Must be completely hydrated and free of grit.
Lime for textile dyeing	Calcium carbonate ( $\text{CaCO}_3$ ) not less than 94%, alumina-iron not more than 2%, silica not more than 2.5% and magnesia not more than 3%.	
Varnish	Must be very low in iron and magnesium oxide.	Must be very fine grained and very white.

1/ This table indicates such chemical and physical requirements as have been standardized by the various consuming industries.

Table 3.--Chemical analyses of carbonate rock samples from the Tule River Indian Reservation.

(Modified from J. H. Kleinfelder and Associates, 1977, table 4, p. 26b)

Sample No.	Drill Hole	Depth Feet	CaO	CaCO <sub>3</sub>	MgO	MgCO <sub>3</sub>	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Na <sub>2</sub> O	K <sub>2</sub> O	TiO <sub>2</sub>	P <sub>2</sub> O <sub>5</sub>	MnO	Loss on ignition
1	1	9-14	46.2	82.4	5.5	11.4	5.7	0.65	0.20	0.31	0.17	<0.02	0.06	0.008	36.24
2	1	44	46.2	82.4	1.8	3.8	5.6	1.38	.40	.04	.24	< .02	.06	.014	35.90
3	2	15	39.2	69.9	1.3	2.7	17.4	4.00	.99	.34	.04	.11	.06	.034	29.32
4	3	10	6.86	12.2	7.1	14.9	51.3	15.2	10.6	1.62	1.43	1.97	.50	.155	3.60
5	3	10-20	21.0	37.5	20.7	43.3	14.6	5.0	2.4	.71	.19	.33	.19	.046	35.71
6	4	35	28.0	50.0	21.4	44.8	4.4	.85	.23	.04	.10	< .02	.06	.013	44.76
7	5	30-35	29.4	52.5	21.7	45.4	3.0	.25	.063	.01	.02	< .02	.03	.009	40.77
8	5	70	28.0	50.0	20.6	41.1	3.2	.30	.009	.04	.01	< .02	.03	.012	47.42
9	6	20	19.6	35.0	22.9	47.9	11.4	5.20	1.4	.34	.02	.19	.19	.031	37.17
10	6	60	29.4	52.5	19.1	39.9	4.4	1.20	.42	.14	.03	.03	.13	.018	44.95
11	7	20	32.1	57.5	15.1	31.6	12.2	2.95	1.0	.34	.39	.11	.13	.027	28.57
12	7	55	29.4	52.5	17.7	37.0	9.0	2.20	1.0	.36	.53	.08	.09	.021	33.00
13	7	92	19.6	35.0	14.8	31.0	29.0	9.15	3.0	1.27	3.5	.33	.06	.027	15.50
14	8	40	16.8	30.0	17.2	36.0	30.6	9.35	5.1	.82	1.24	.37	.06	.034	16.57
15	9	8	32.2	57.5	22.1	46.2	4.5	.65	.22	.24	.08	< .02	.06	.012	39.80
16	10	2	28.0	50.0	20.7	43.3	6.2	1.25	.58	.31	.01	< .02	.06	.021	43.45
17	10	50	28.0	50.0	20.7	43.3	6.4	1.75	.55	.30	.02	< .02	.06	.018	42.75
18	10	80	23.8	42.5	18.7	39.1	16.5	4.45	2.1	.47	.24	.16	.06	.039	31.75
19	N-1	--	<u>30.8</u>	<u>55.0</u>	<u>21.1</u>	<u>44.1</u>	<u>1.7</u>	<u>.3</u>	<u>.069</u>	<u>.01</u>	<u>.01</u>	<u>&lt; .02</u>	<u>.06</u>	<u>.017</u>	<u>45.27</u>
Average			28.14	50.2	16.3	34.0	12.5	3.48	1.60	0.406	0.435	<0.20	0.10	0.029	34.34
Dolomite: Average chemical comp.			30.1	53.6	21.5	45.0	1.1	0.1	0.1	--	--	--	--	--	47.0
Limestone: Average chemical comp.			42.6	76.0	7.9	16.5	5.2	0.8	0.5	0.1	0.3	--	--	--	41.6



- |                      |                         |
|----------------------|-------------------------|
| 1. Alturas           | 11. Likely              |
| 2. Berry Creek       | 12. Lone Pine           |
| 3. Big Pine          | 13. Lookout             |
| 4. Bishop            | 14. Santa Rosa          |
| 5. Cedarville        | 15. Sheep Ranch         |
| 6. Cold Springs      | 16. Shingle Springs     |
| 7. Enterprise        | 17. Susanville          |
| 8. Fort Bidwell      | 18. Tule River          |
| 9. Fort Independence | 19. Tuolumne            |
| 10. Jackson          | 20. A, B, C, D XL Ranch |

**Figure 1a.** Index to U.S. Geological Survey topographic maps for areas including the central California Indian reservations (Figures 1b, 1c, and 1d follow).

SACRAMENTO 2° SHEET

SAN JOSE 2° SHEET

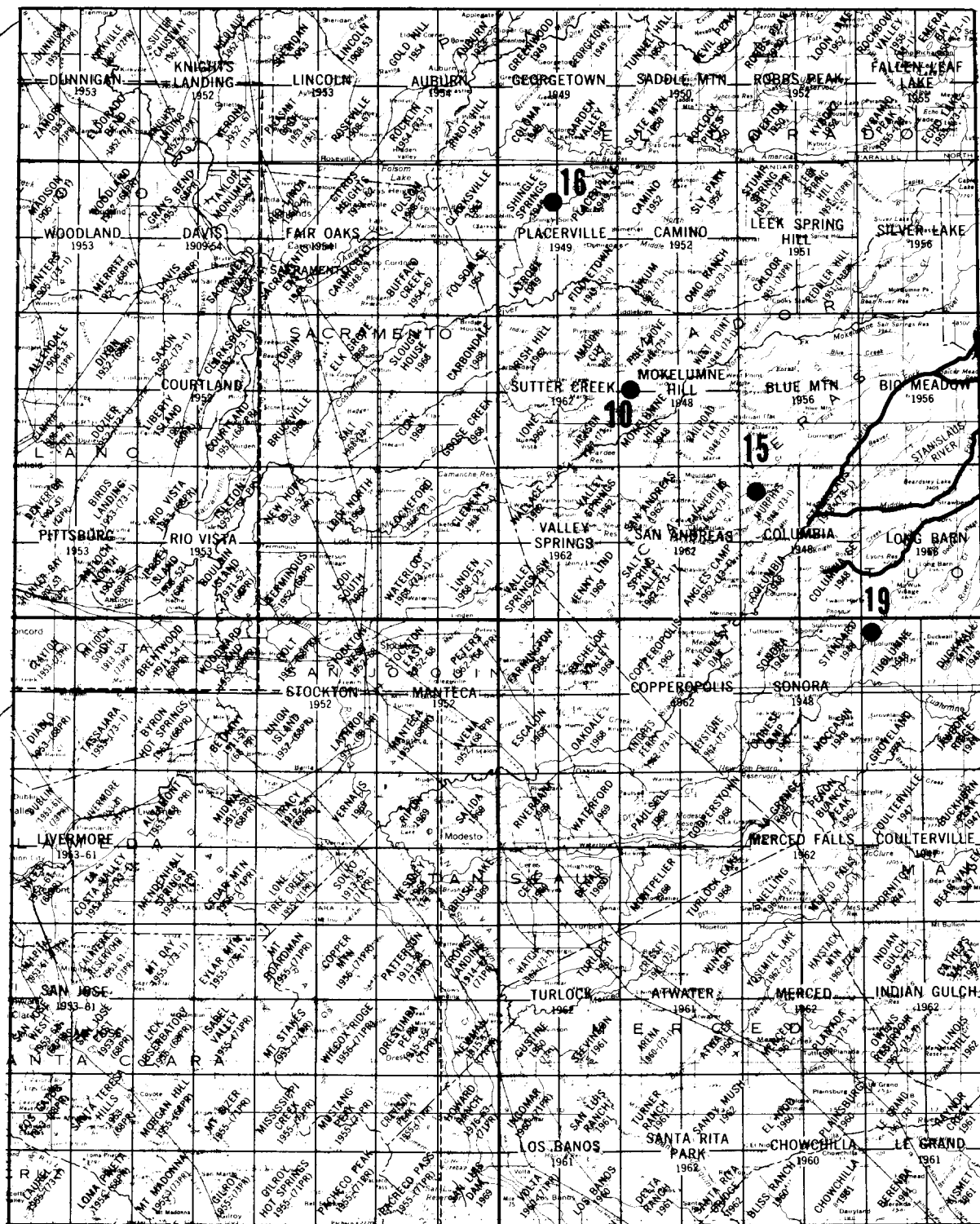


Figure 1b.

MARIPOSA 2° SHEET

FRESNO 2° SHEET

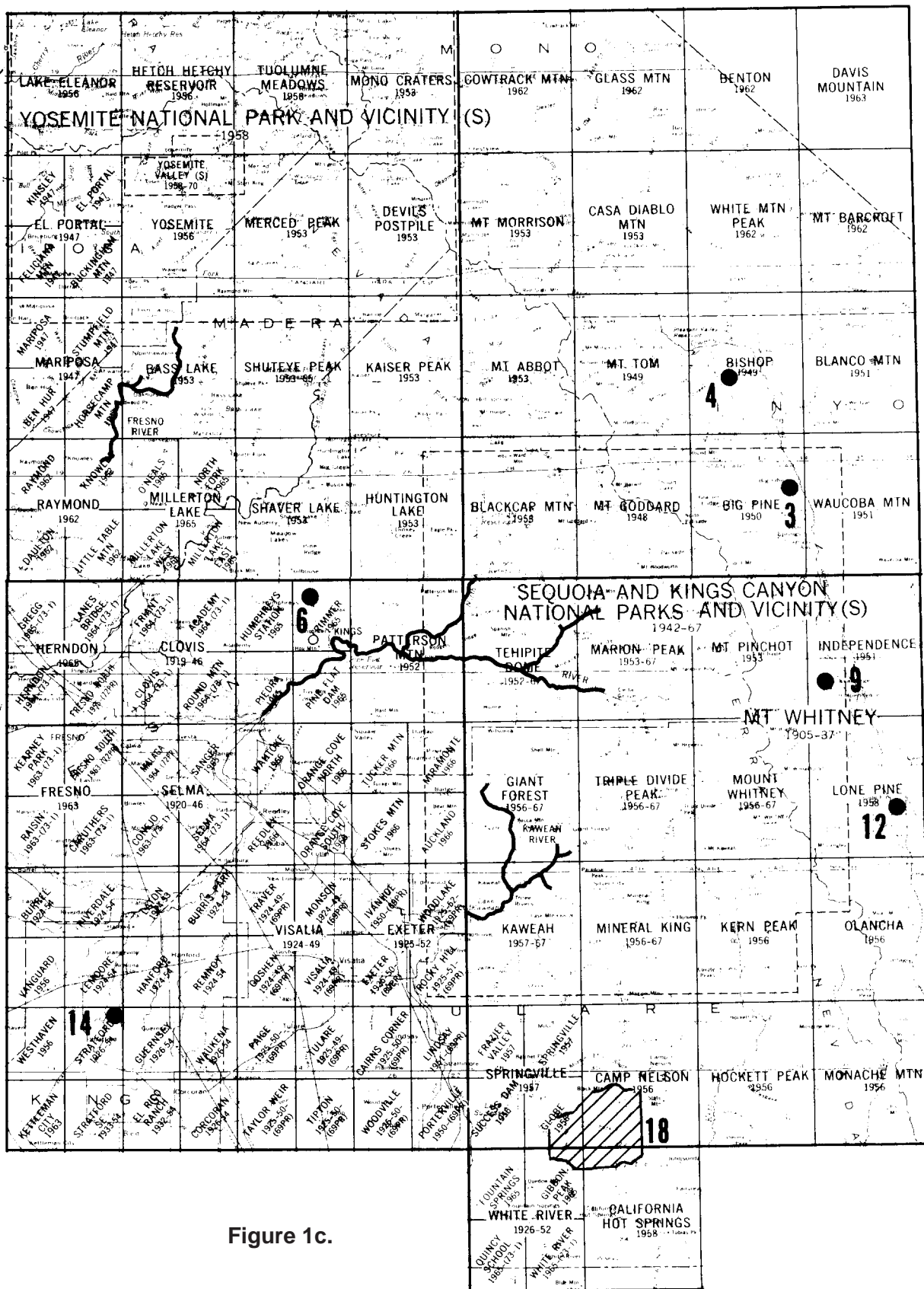


Figure 1c.

SUSANVILLE 2° SHEET

CHICO 2° SHEET

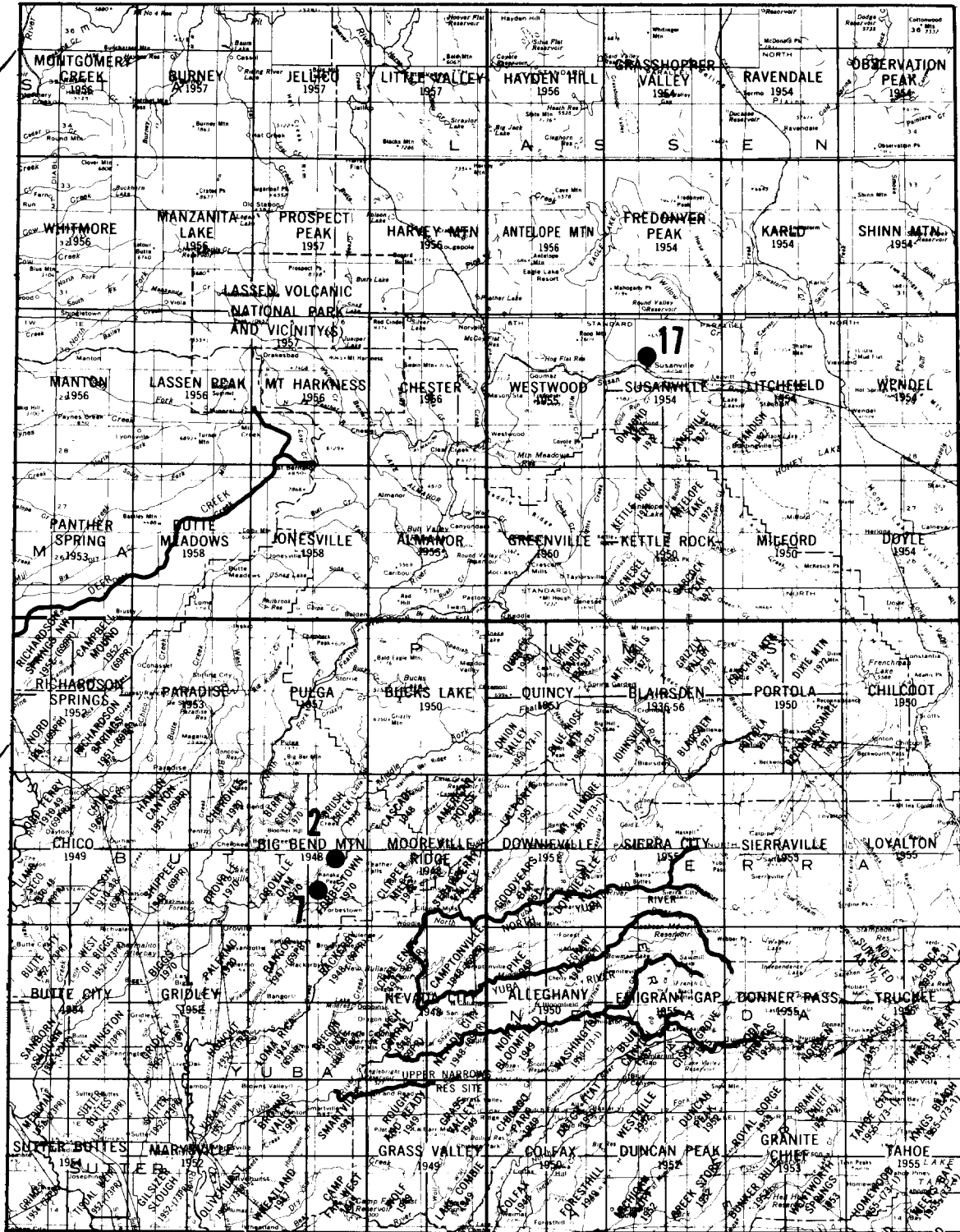
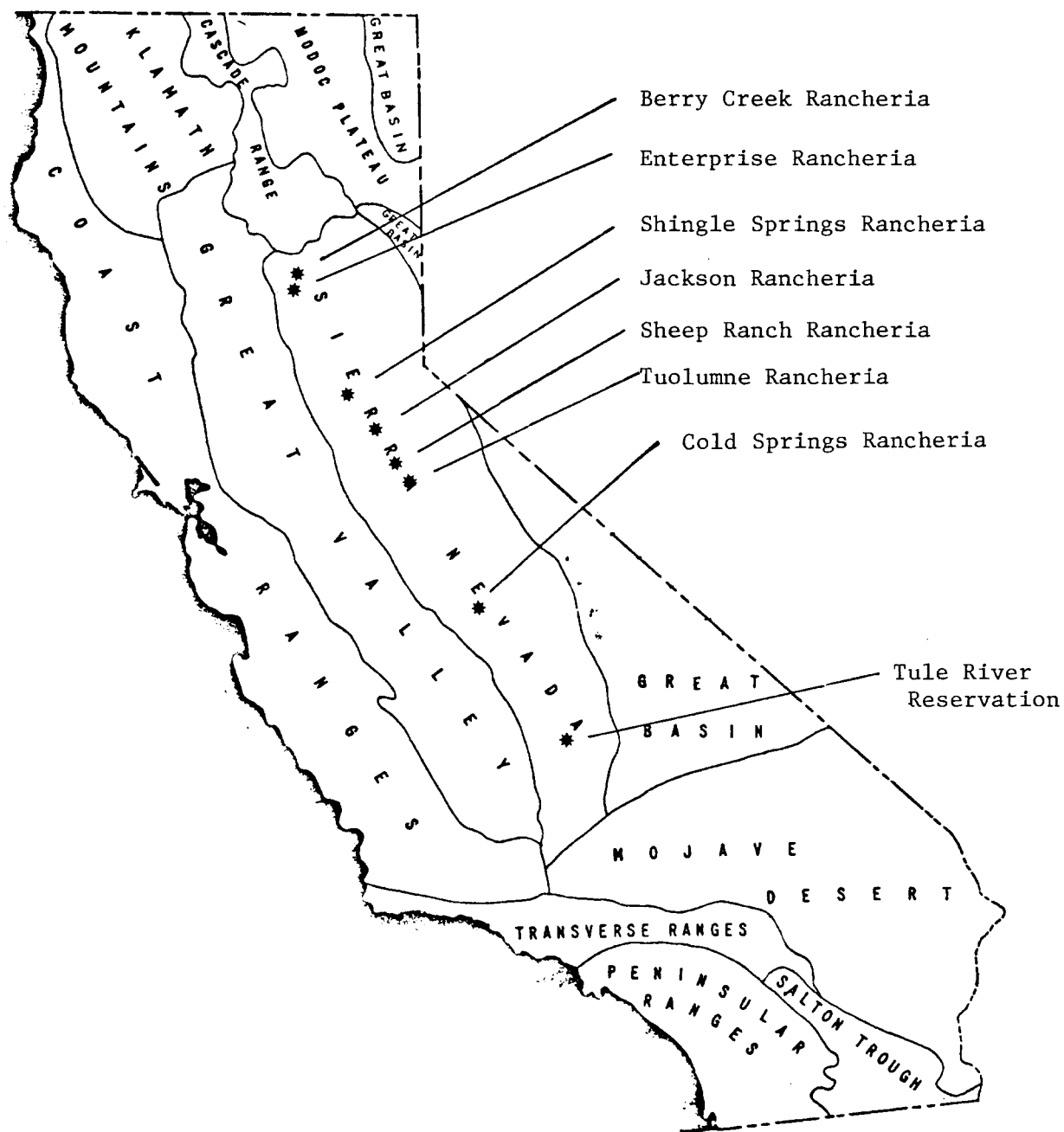
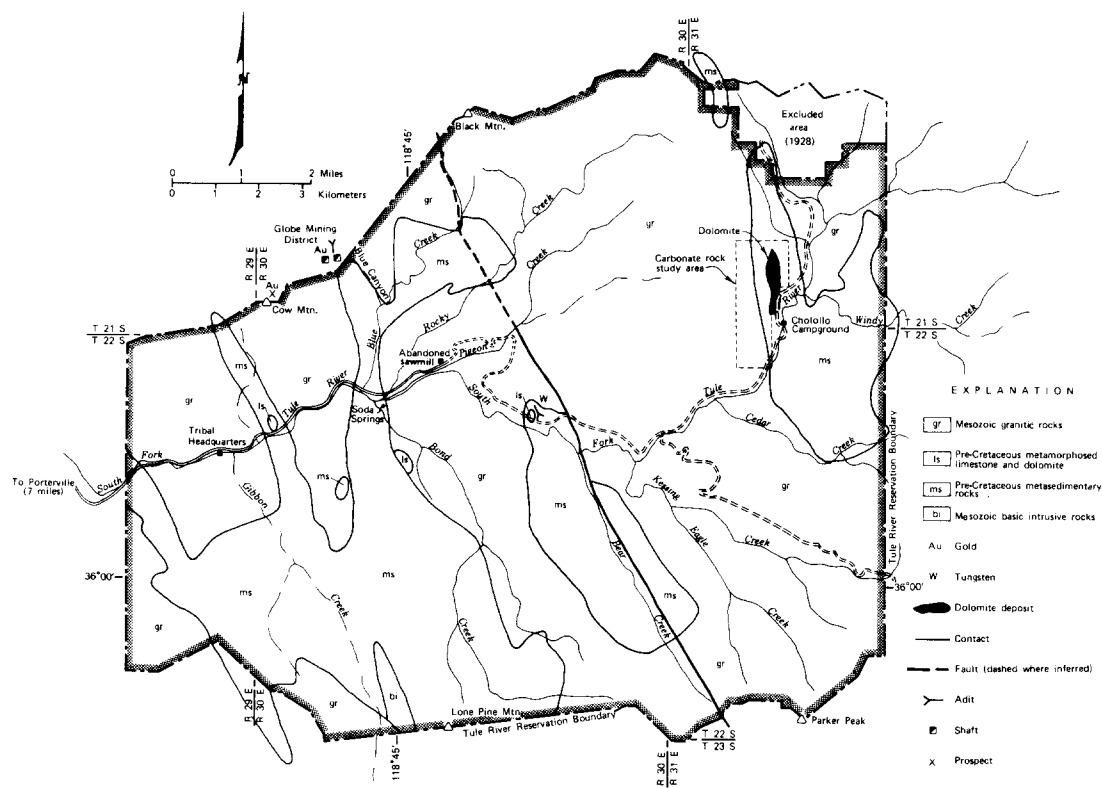


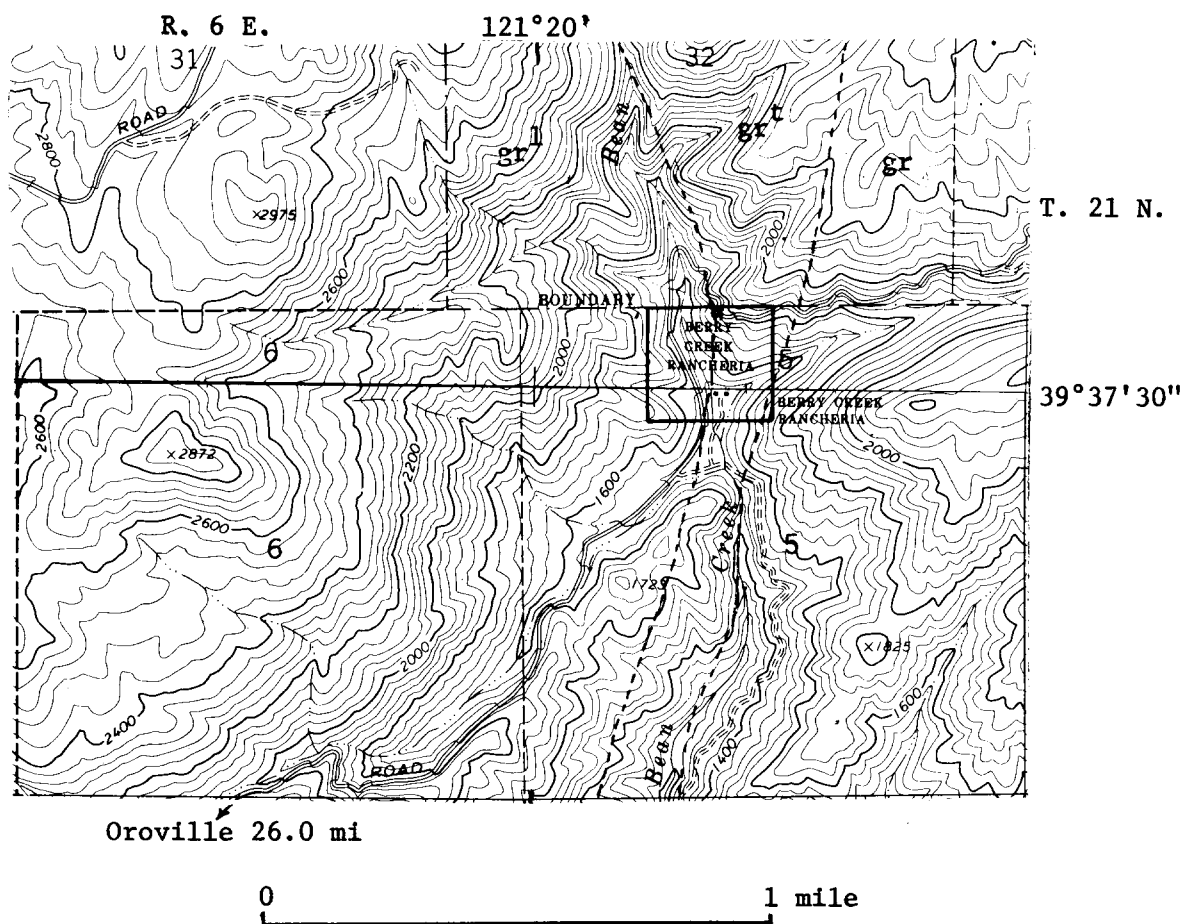
Figure 1d.



**Figure 2.** Index map showing location of Indian lands in the Sierra Nevada Province, California.

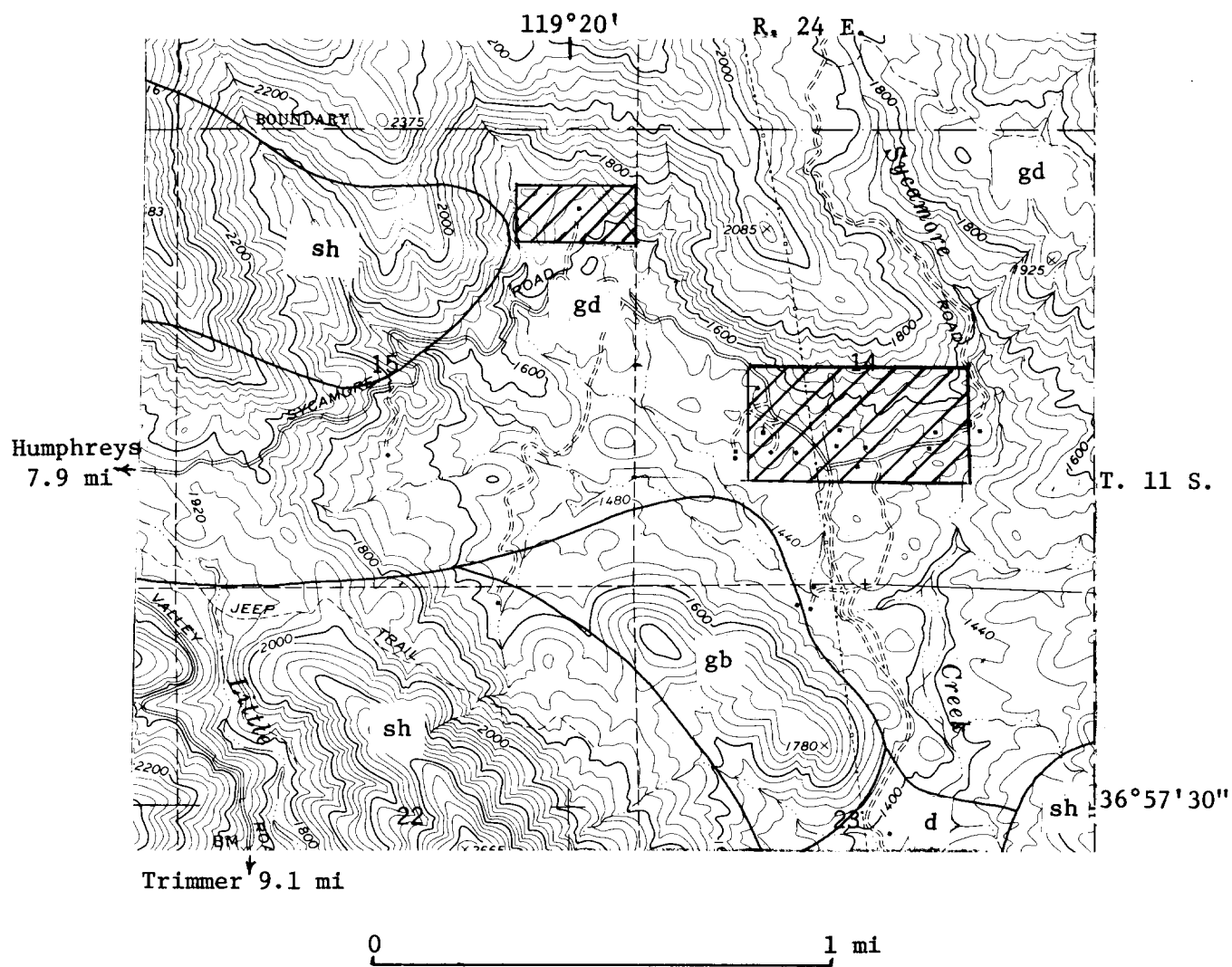


**Figure 3.** Map showing geology and mineral occurrences on and near the Tule River Indian Reservation, California.

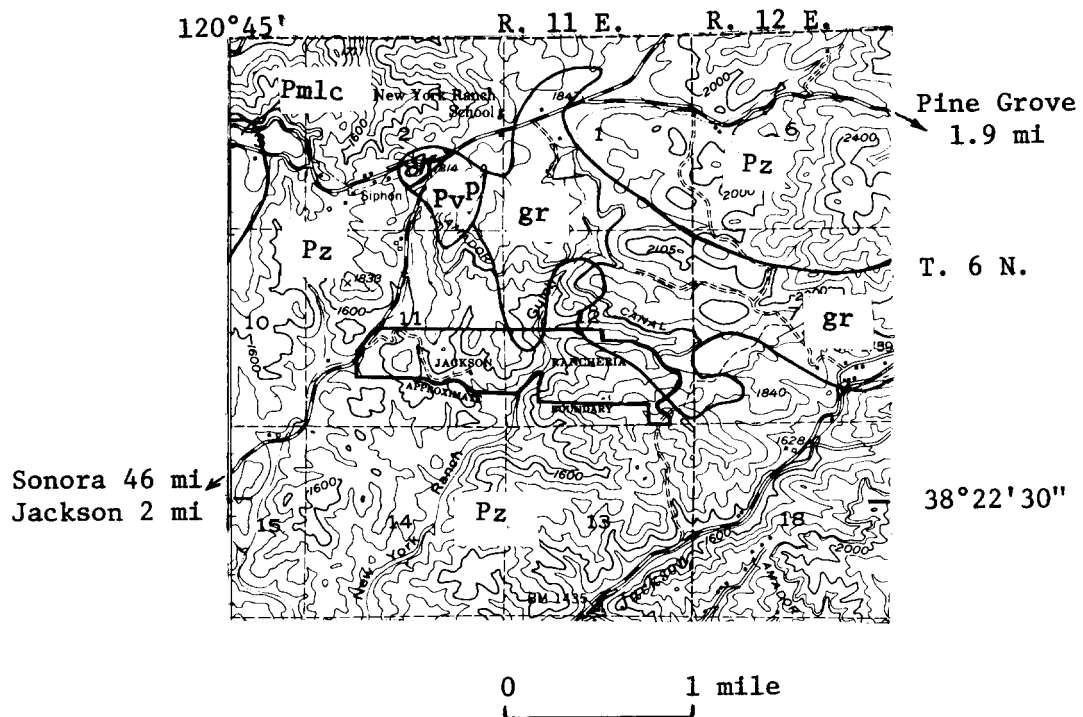


**Figure 4.** Geology of the Berry Creek Rancheria and surrounding area (after Compton, 1955). All rocks are of Jurassic age. gr=granodiorite; gr<sup>1</sup>=leucotondhjemite; gr<sup>†</sup>=trondhjemite.

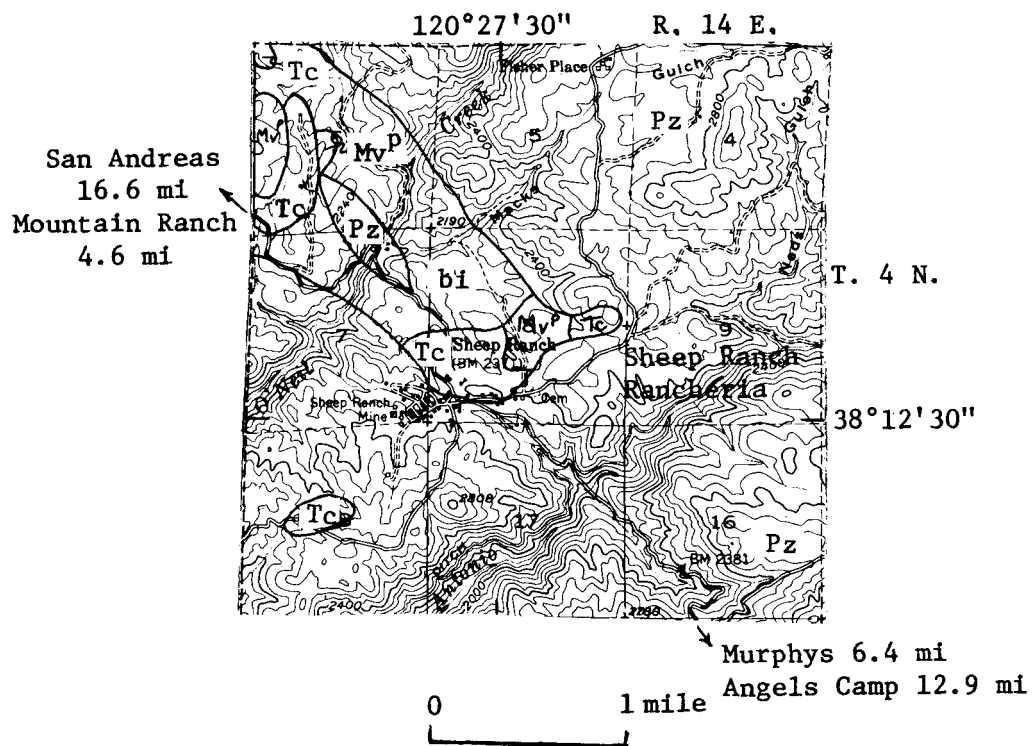




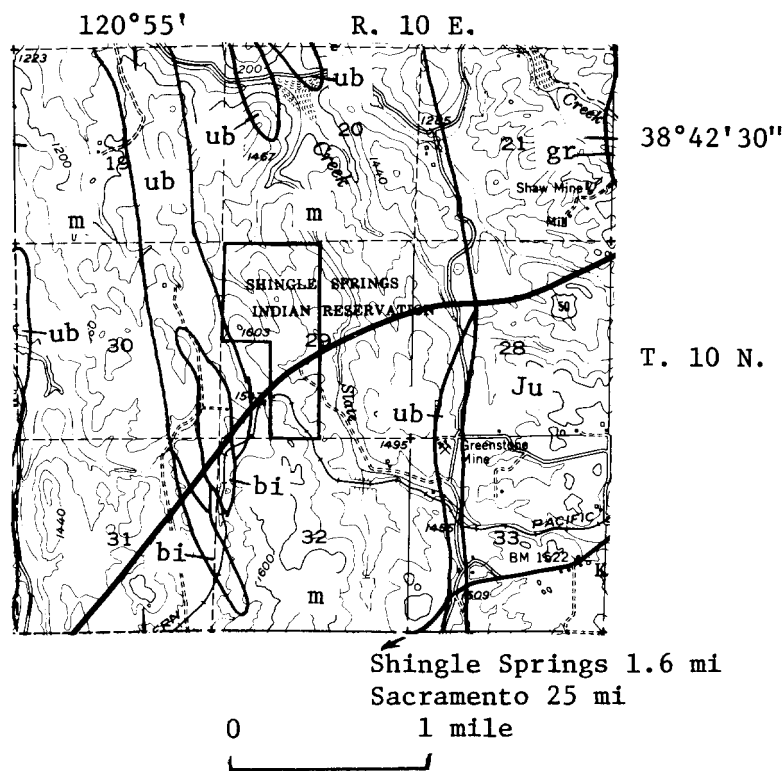
**Figure 6.** Geology of the Cold Springs Rancheria and surrounding area (from Krauskopf, 1953). Rancheria areas are crosshatched. Jurassic (?) rocks include "Dinkey Creek" type hornblende-biotite granodiorite migmatite (gd); diorite (d); gabbro (gb). Pre-Cretaceous rocks are schist and hornfels (sh).



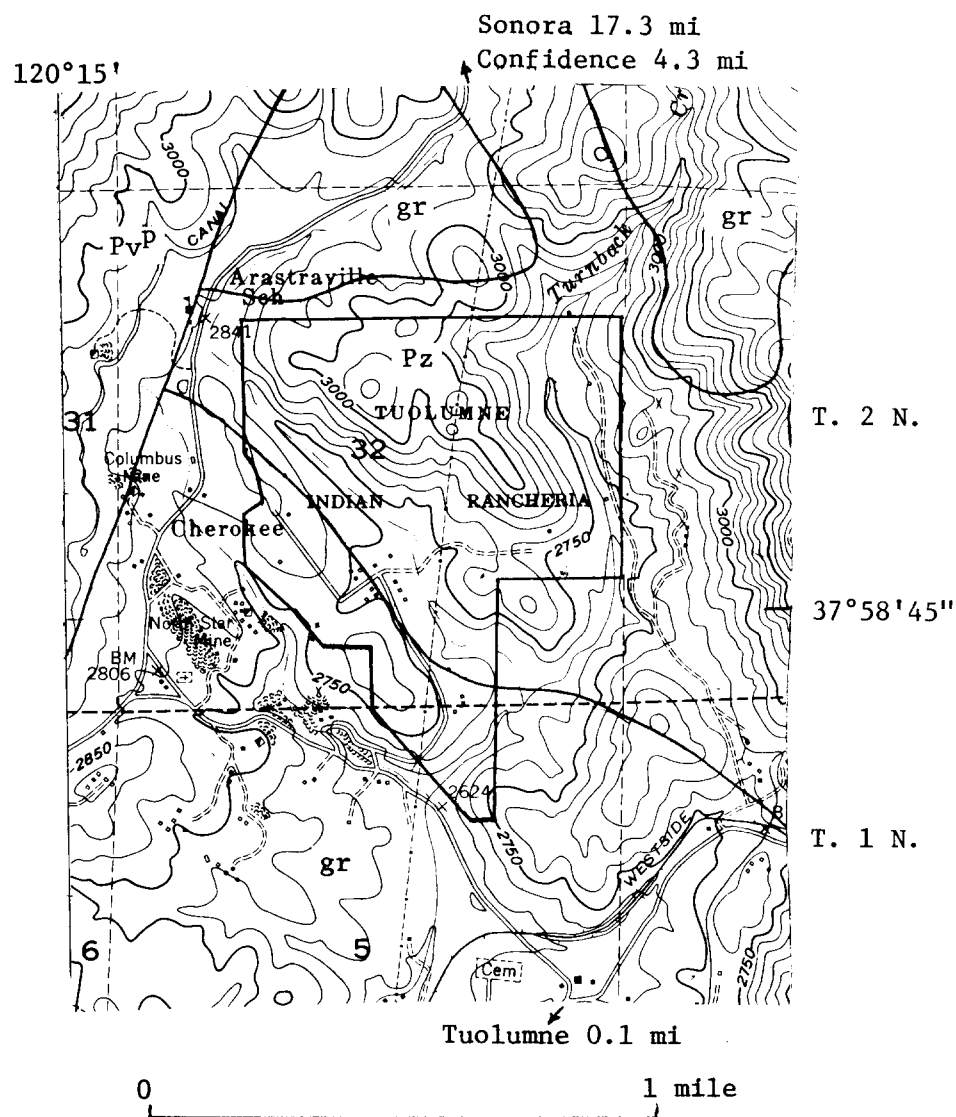
**Figure 7.** Geologic map of the Jackson Rancheria and surrounding area (from Strand and Koenig, 1965). Pliocene fluvial deposits (Pmlc); Pliocene pyroclastic volcanic rocks (PvP); Mesozoic granite and adamellite (gr); Paleozoic marine sedimentary rocks (Pz).



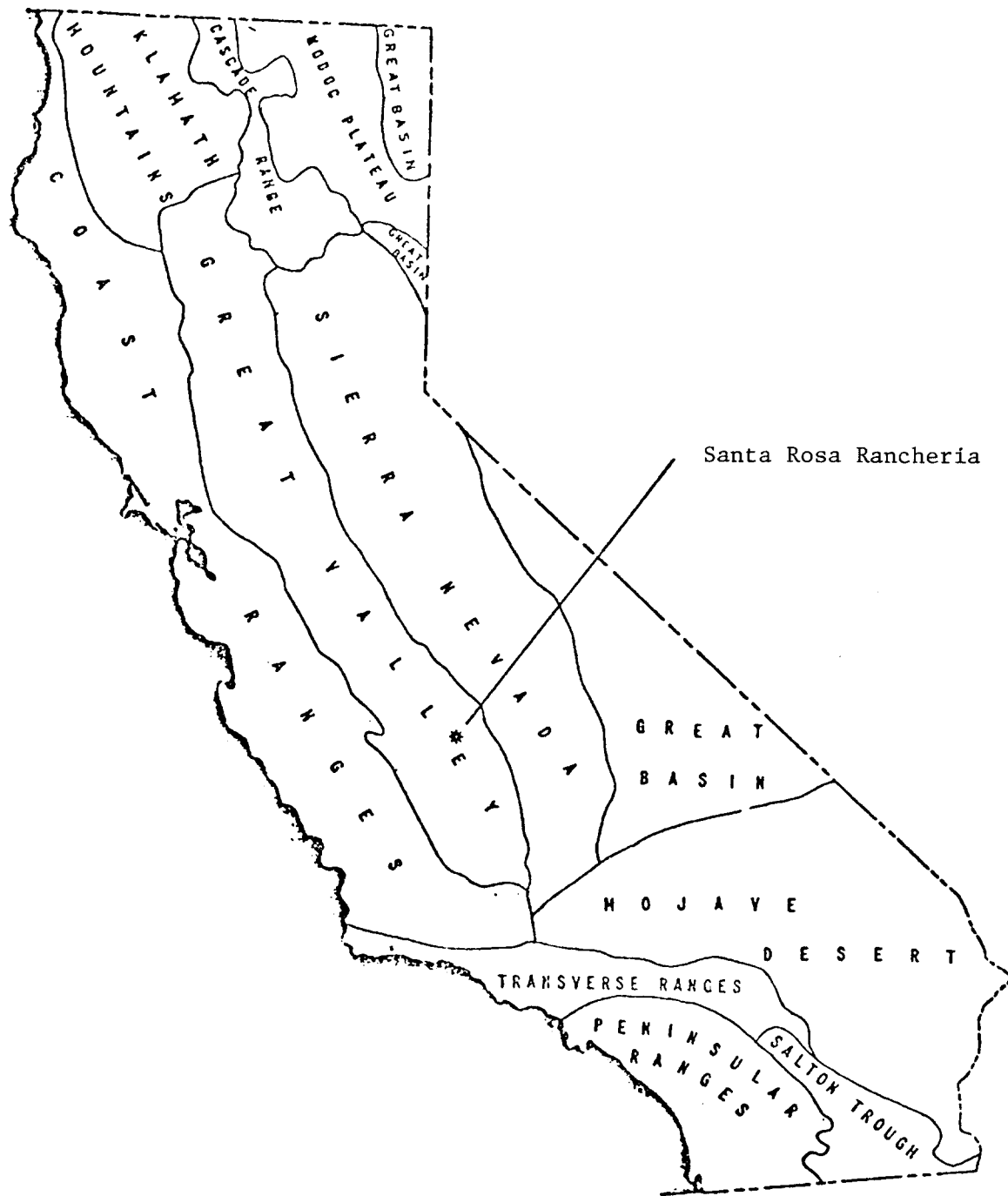
**Figure 8.** Geologic map of the Sheep Ranch Rancheria and surrounding area (from Strand and Koenig, 1965). Miocene pyroclastic volcanic rocks (MvP); Tertiary fluvial deposits (Tc); Jurassic-Cretaceous mafic intrusive rocks (bi); Paleozoic marine rocks (Pz).



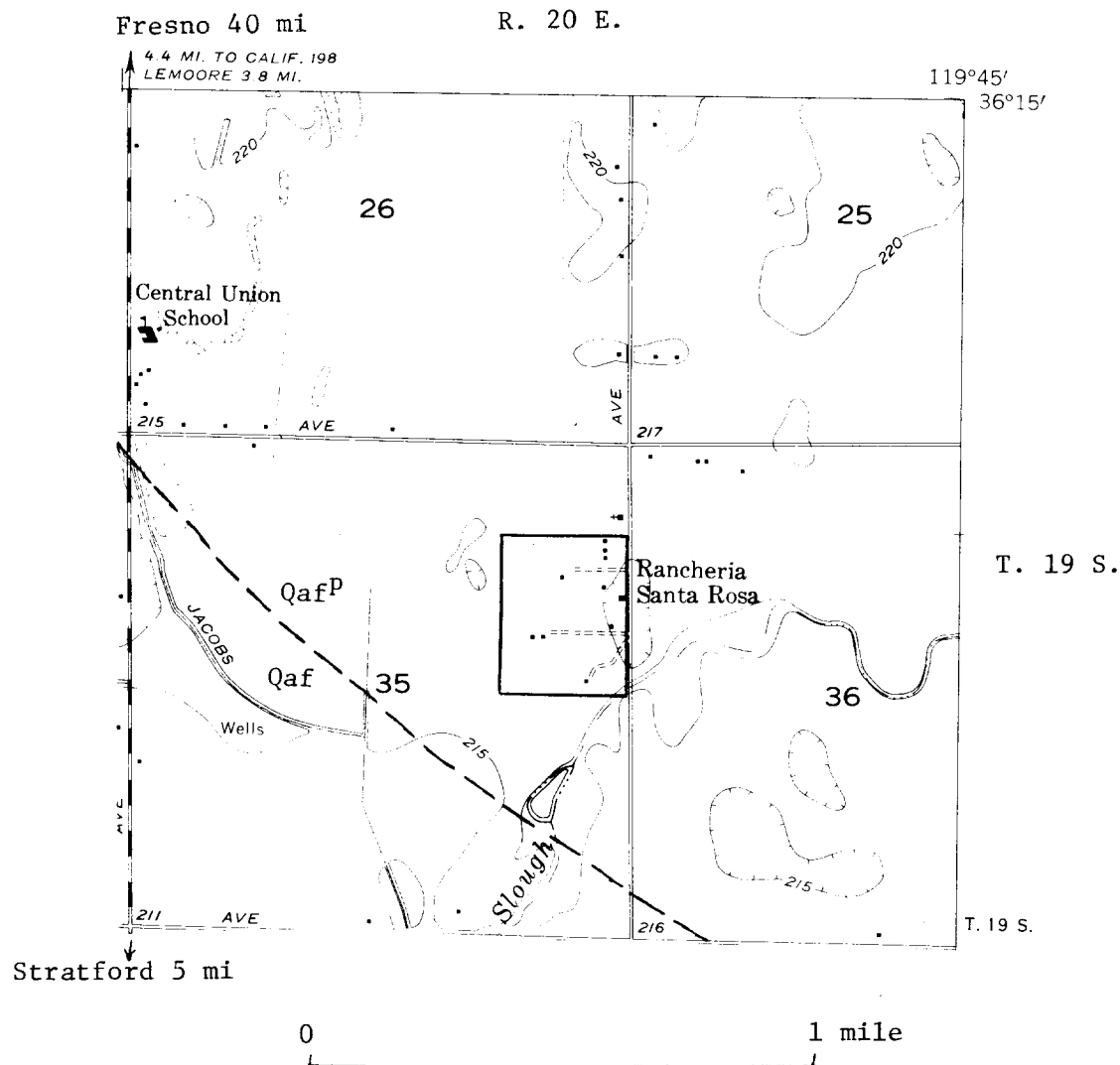
**Figure 9.** Geologic map of the Shingle Springs Rancheria and surrounding area (from Strand and Koenig, 1965). Jurassic marine sedimentary rocks (Ju); Mesozoic granitic rocks (gr); mafic intrusive rocks (bi); Ultramafic intrusive rocks (ub); pre-Cretaceous metamorphic rocks (m).



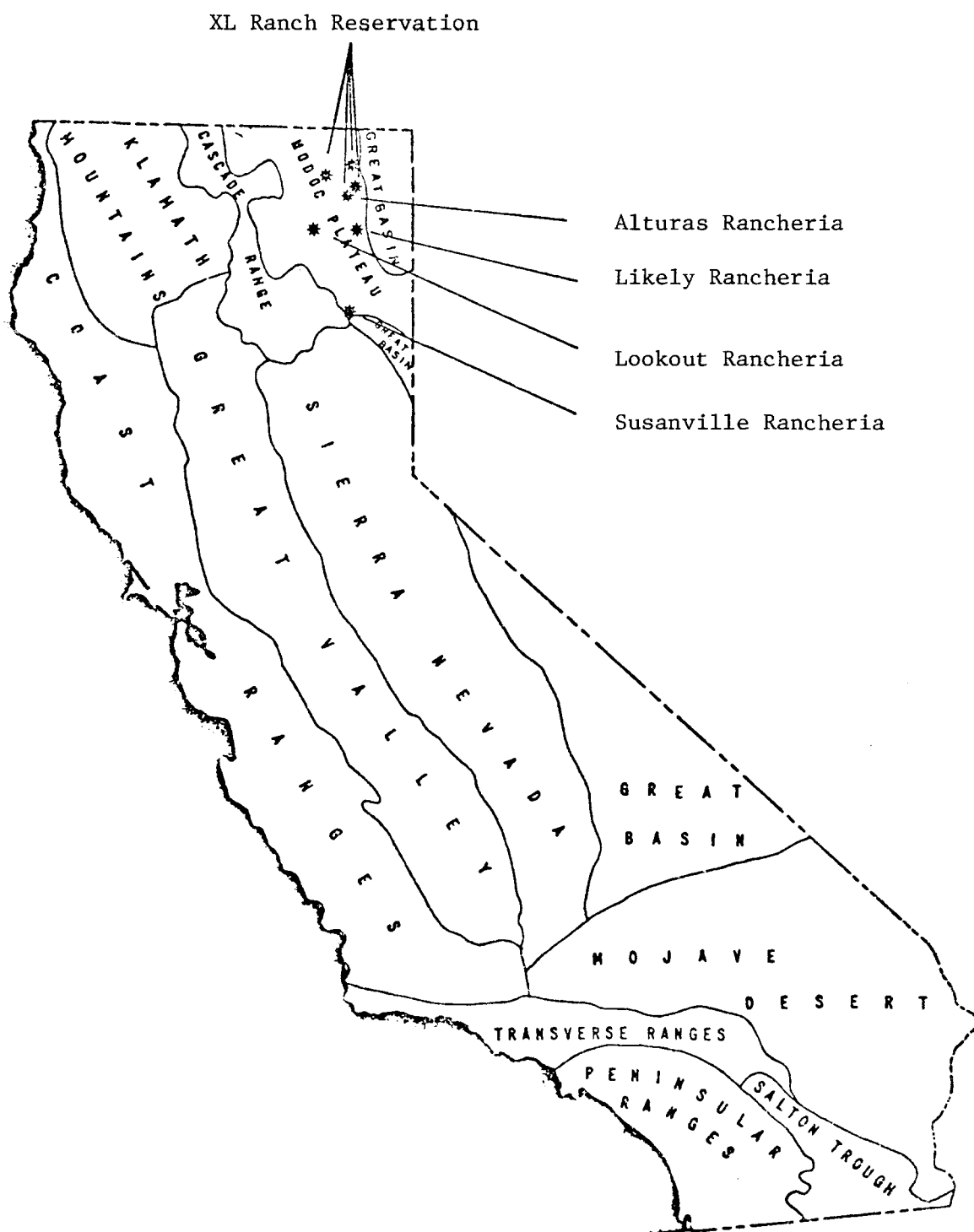
**Figure 10.** Geologic map of the Tuolumne Rancheria and surrounding area (from Rogers, 1966). Pliocene pyroclastic volcanic rocks (PvP); Mesozoic granite (gr); Paleozoic marine sedimentary rocks (Pz).



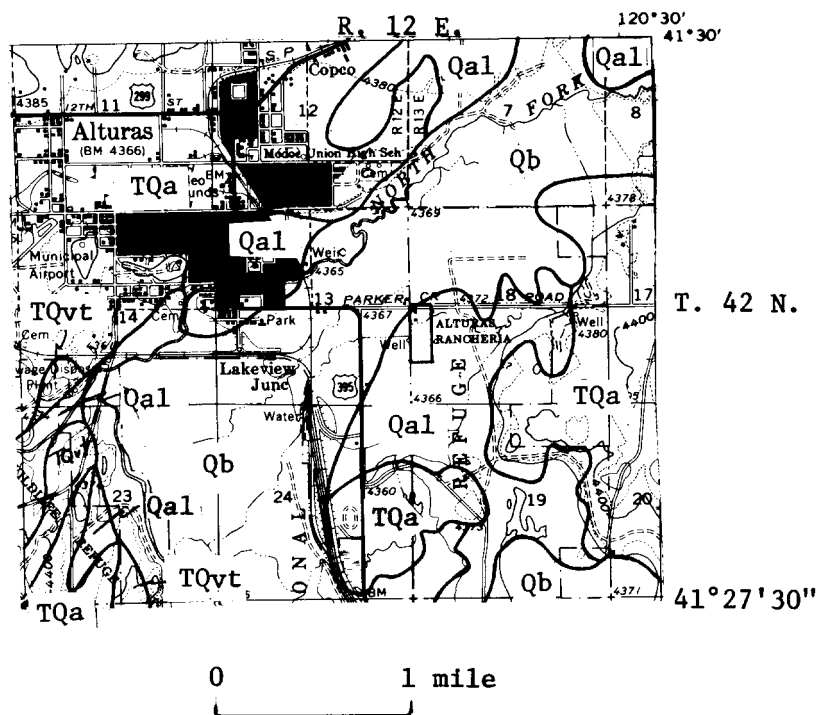
**Figure 11.** Index map showing location of Indian lands in Great Valley Province, California.



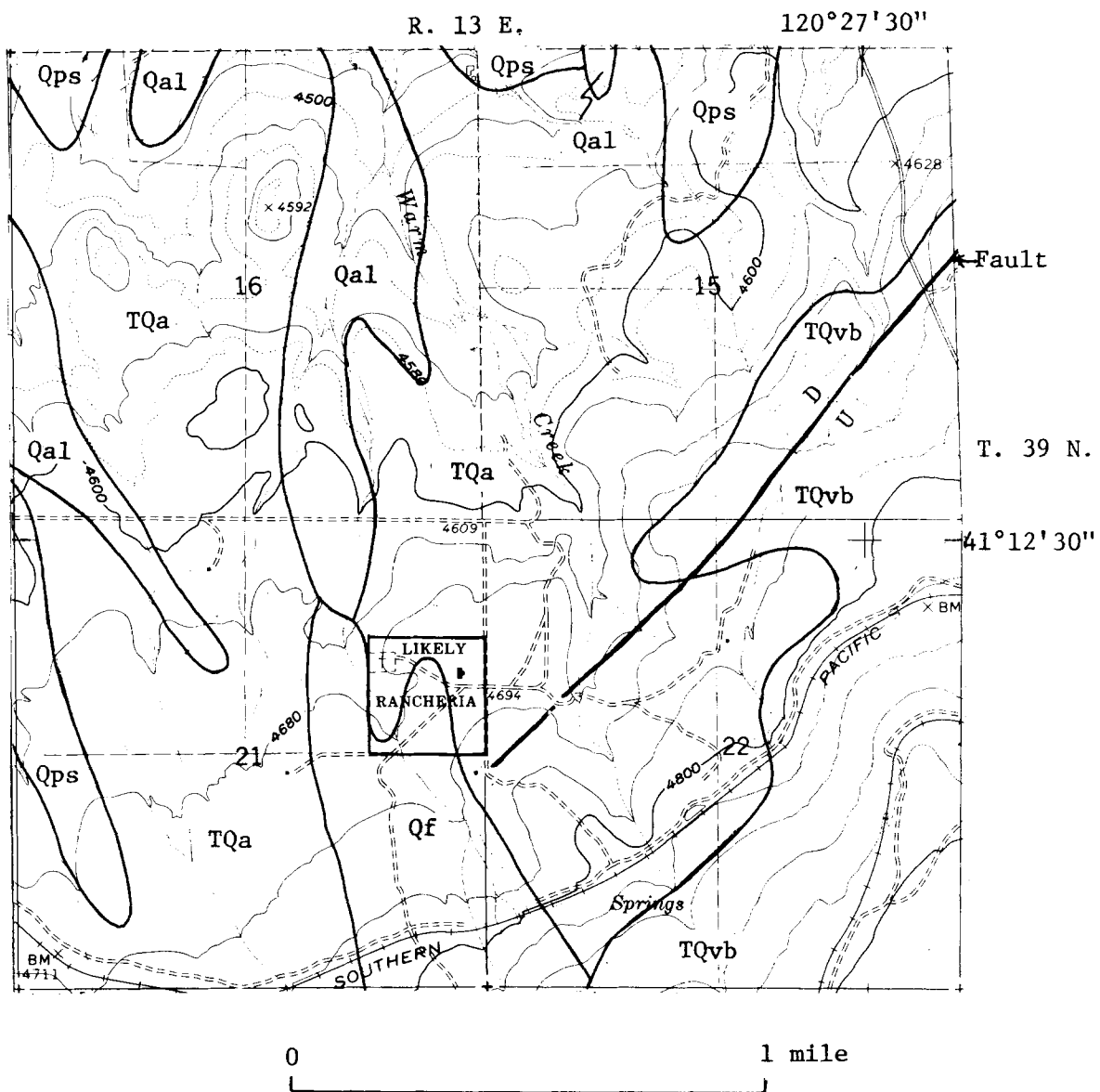
**Figure 12.** Geologic map of the Santa Rosa Rancheria and surrounding area (from Davis and others, 1964). Alluvial fan and basin-rim soils (Qaf); relatively permeable deposits (QafP). Gravel and sand constitute more than one-third of deposits as estimated from well logs.



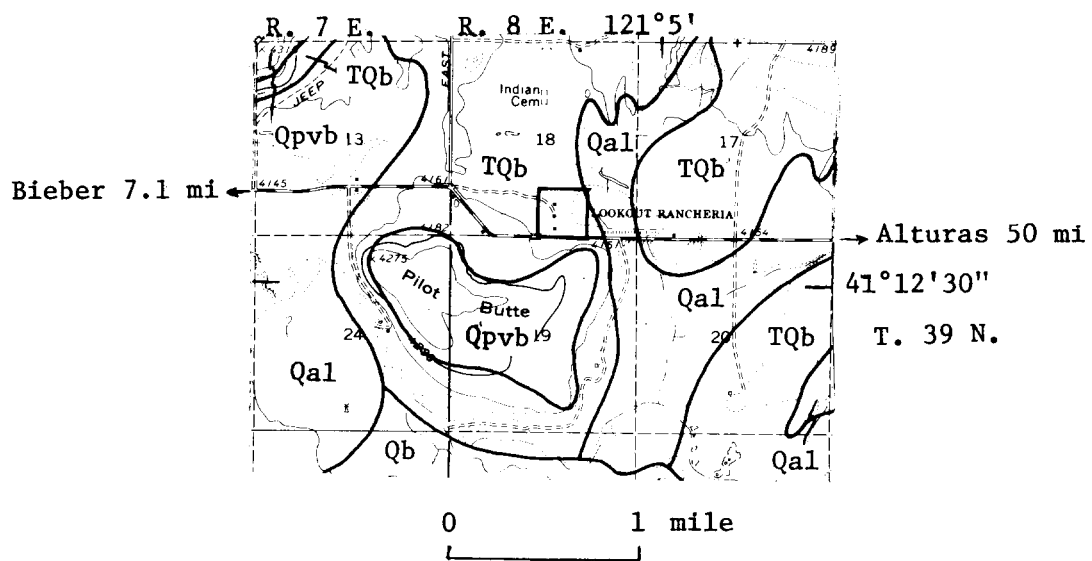
**Figure 13.** Index map showing location of Indian lands in the Modoc Plateau Province, California.



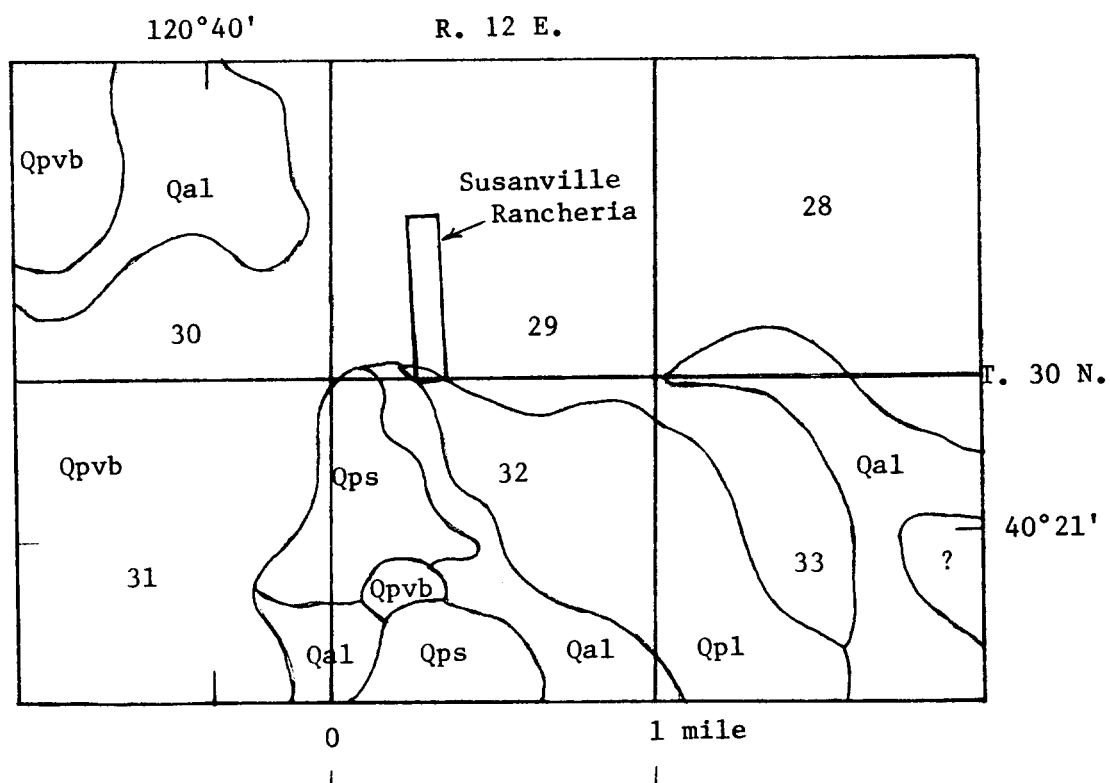
**Figure 14.** Geologic map of the Alturas Rancheria and surrounding area (from California Department of Water Resources, 1963). Recent basin deposits (Qb); Recent alluvium (Qal); Pleistocene Alturas Formation (TQa); Pliocene Warm Springs tuff (TQvt).



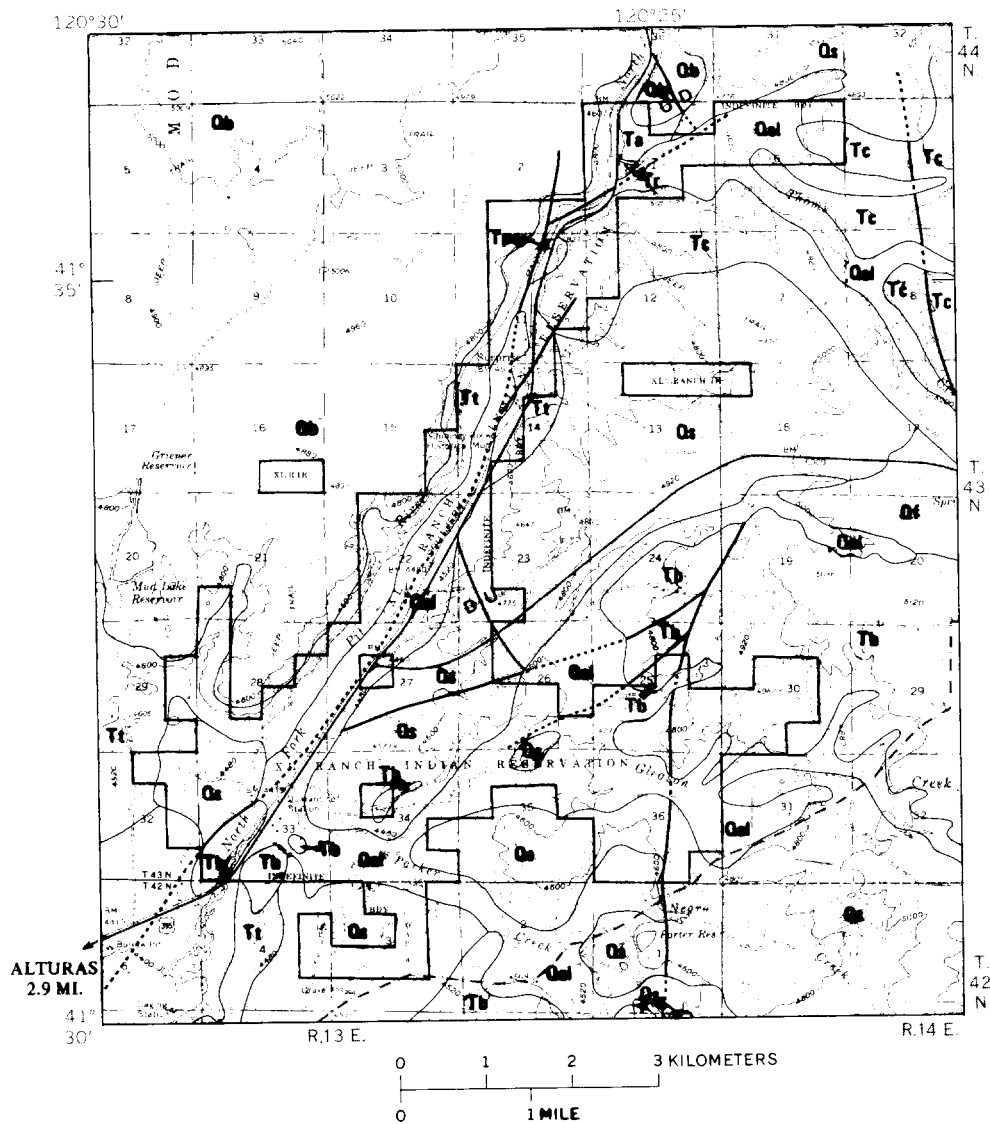
**Figure 15.** Geologic map of the Likely Rancheria and surrounding area (from California Department of Water Resources, 1963). Alluvium (Qal); Alluvial fan deposits (Qf); Pleistocene near-shore deposits (Qps); Alturas Formation (TQa); Pliocene Warm Springs tuff (TQvb). U, upthrown side of fault, D, downthrown side of fault.



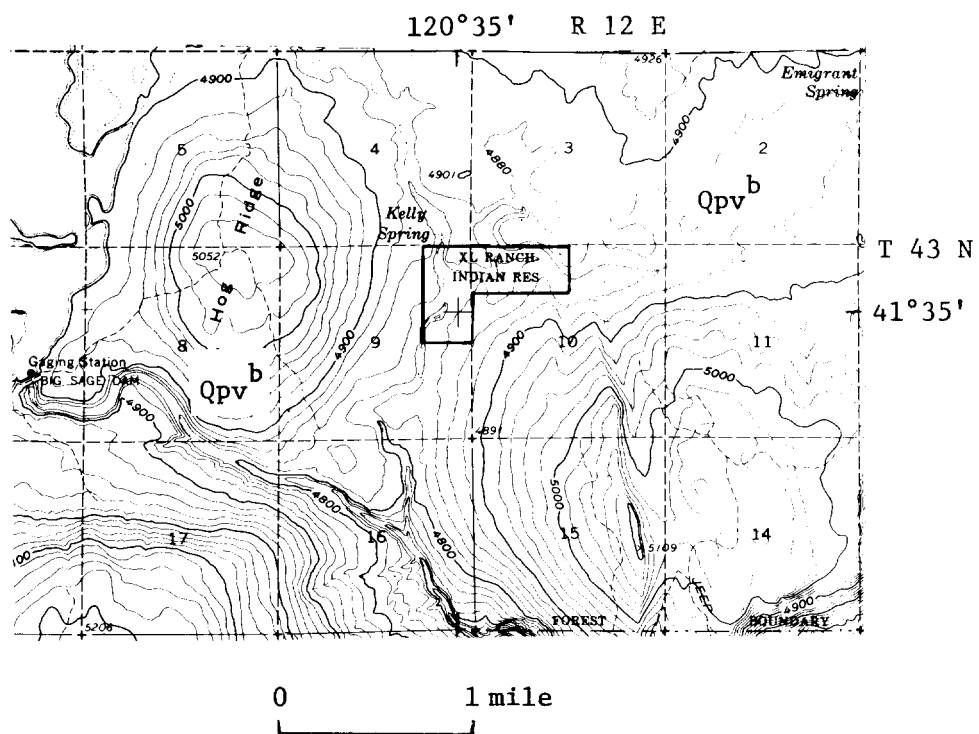
**Figure 16.** Geologic map of the Lookout Rancheria and surrounding area (from California Department of Water Resources, 1963). Recent Basin Deposits (Qb); Alluvium (Qal); Pleistocene basalt (Qpnb); Pliocene Bieber Formation (TQb).



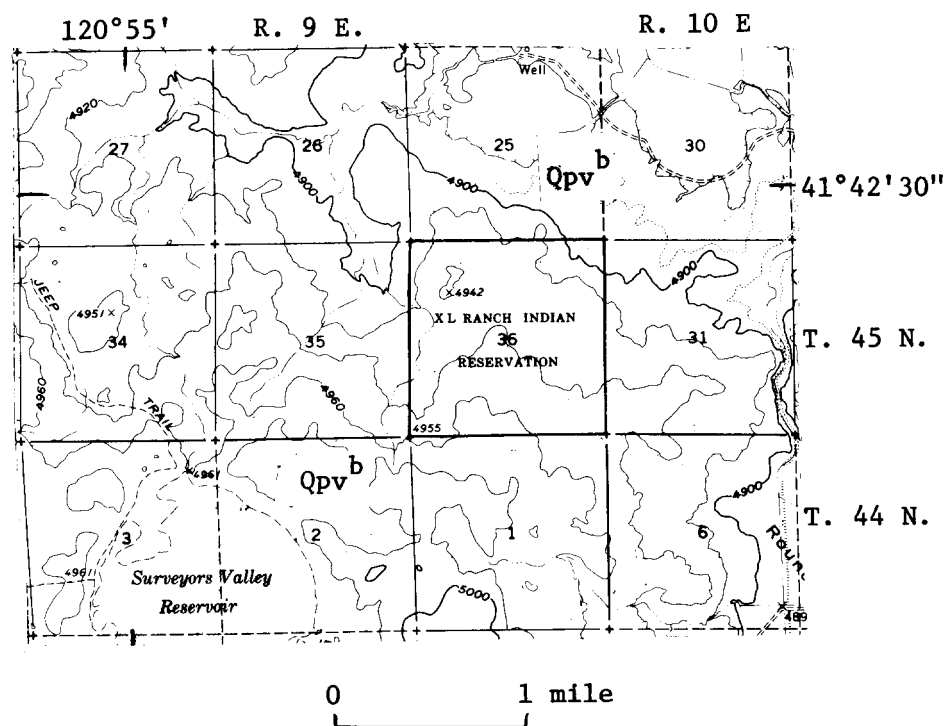
**Figure 17.** Geology of the Susanville Rancheria and surrounding area (from California Department of Water Resources, 1963). Alluvium (Qal); Near-shore deposits (Qps); Pleistocene and Lahontan Lake deposits (Qpl); Pleistocene basalt (Qpvb).



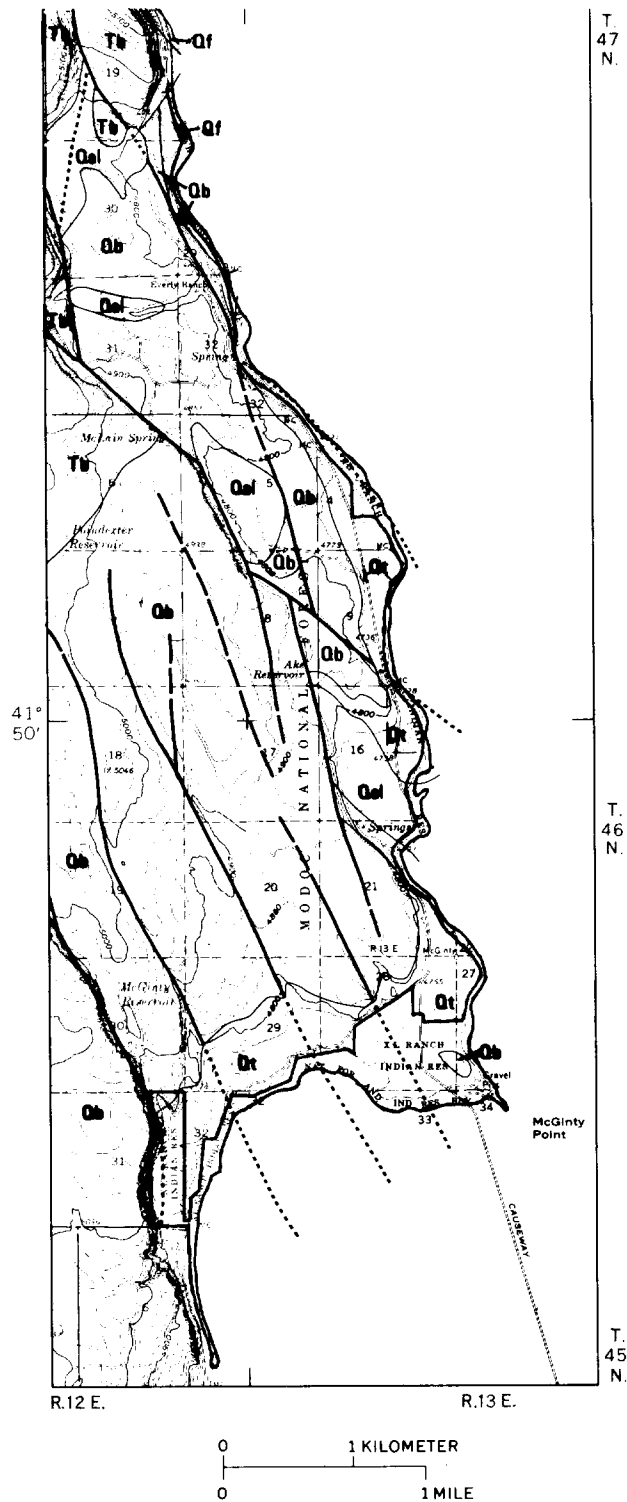
**Figure 18.** Geologic map of the XL Ranch Reservation (area A) and surrounding area (from California Department of Water Resources, 1963). Recent alluvium (Qal); alluvial fan deposits (Qf); Pleistocene near-shore deposits (Qs); Pleistocene Alturas formation (Ta); Pleistocene basalt (Qb); Plio-Pleistocene basalt (Tb); Pliocene tuff (Tt); Pliocene andesite (Tpa); Miocene Cedarville Series (Tc); Rhyolite (Tr); faults (heavy lines) trend north and northeast (dotted lines where concealed).



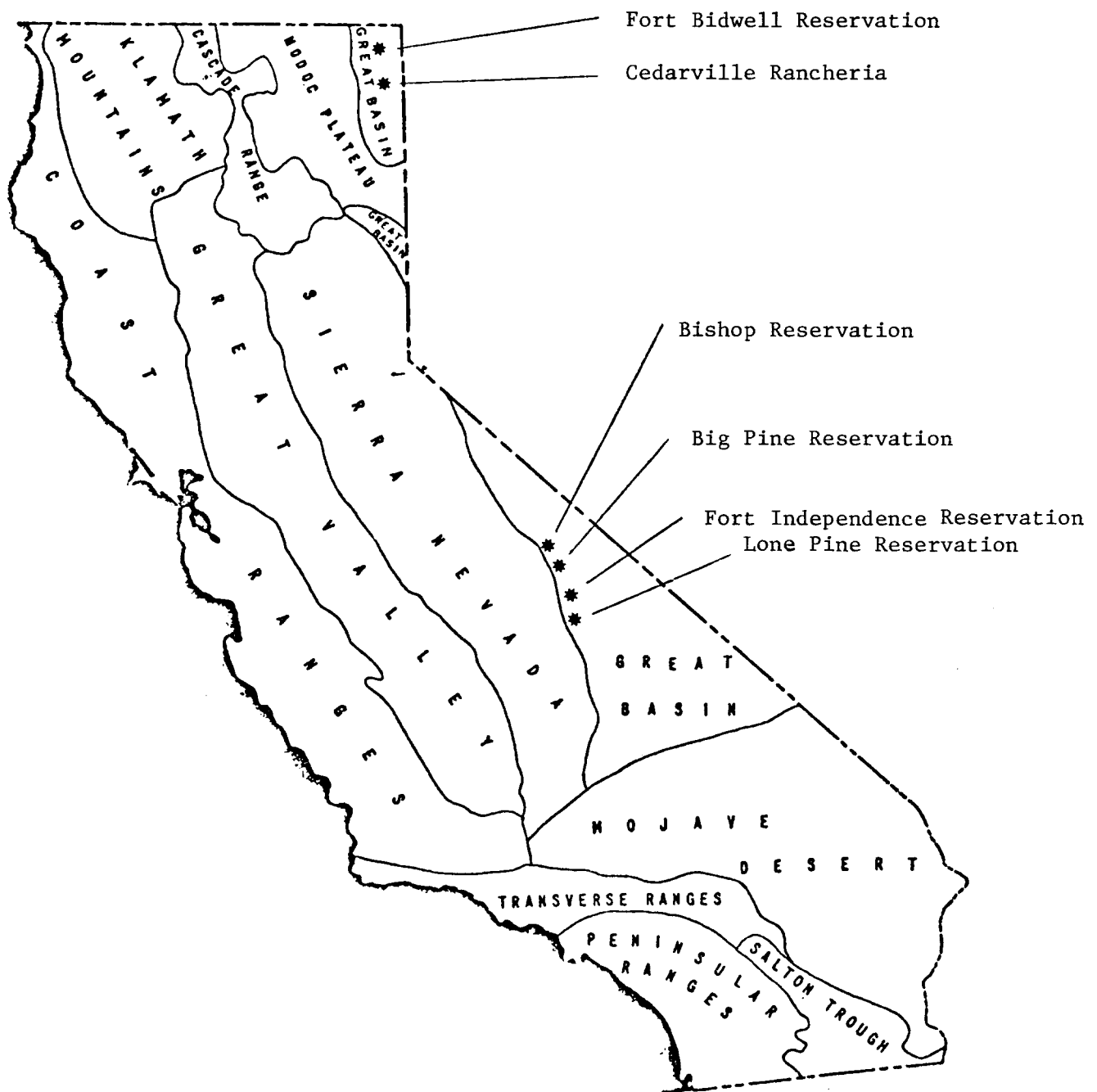
**Figure 19.** Geologic map of the XL Ranch Reservation (area B) and surrounding area (from Gay and Aune, 1958). All rocks are Pleistocene "Warner" basalt (Qpv<sup>b</sup>).



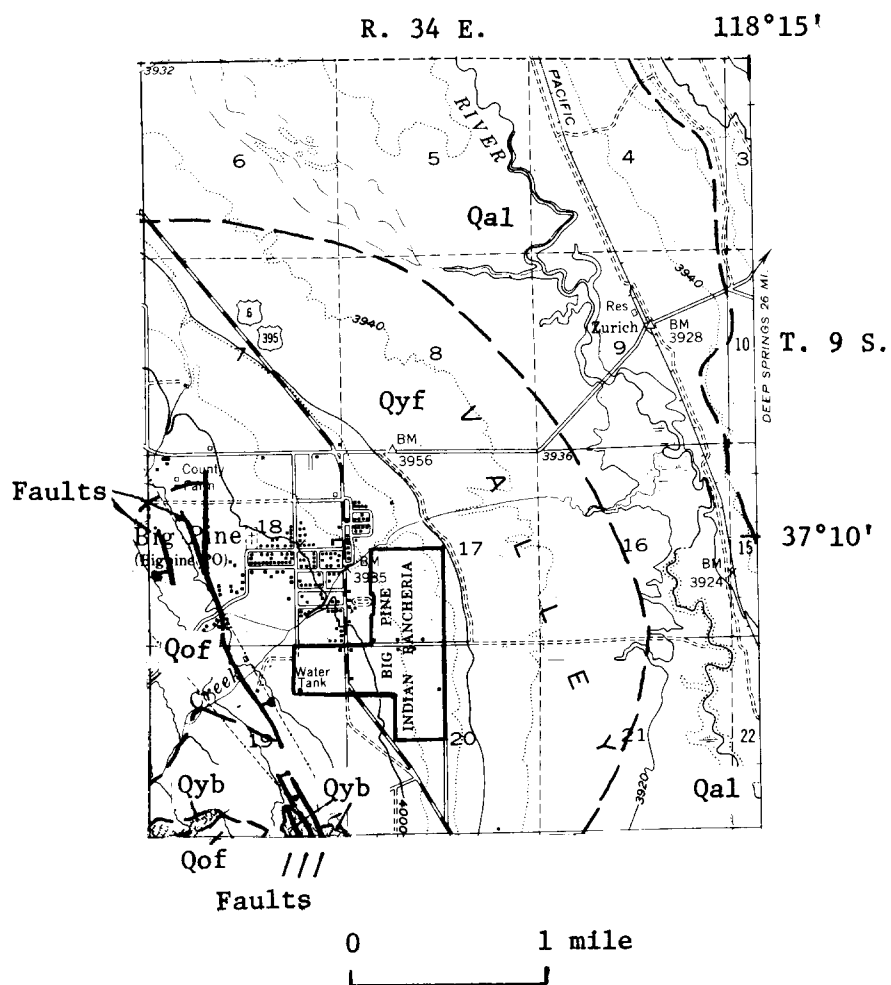
**Figure 20.** Geologic map of the XL Ranch Reservation (area C) and surrounding area (from Gay and Aune, 1958). All rocks are Pleistocene "Warner" basalt (Qpv<sup>b</sup>).



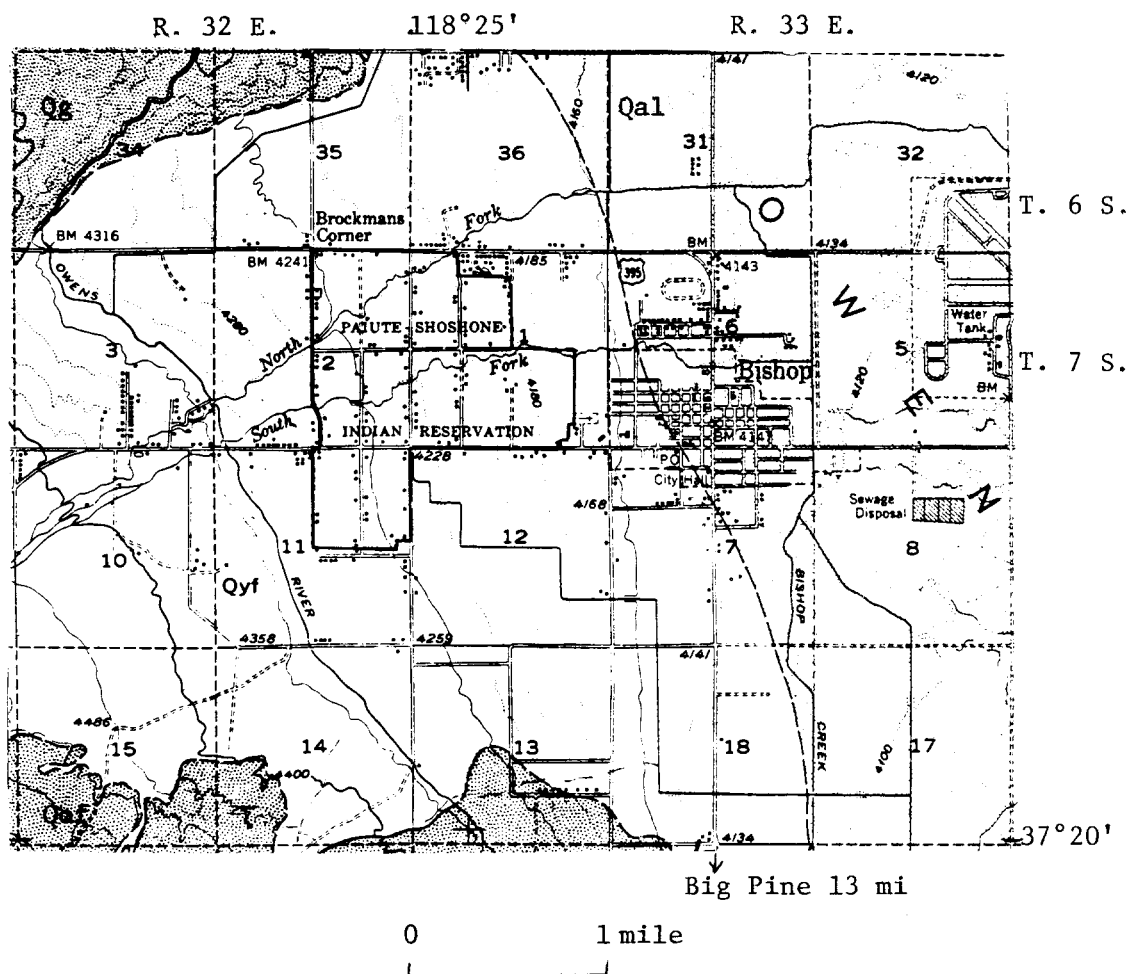
**Figure 21.** Geologic map of the XL Ranch Reservation (area D) and surrounding area (from California Department of Water Resources, 1963). Recent alluvium (Qal); aluvial fans (Qf); Pleistocene terrace deposits (Qt); Pleistocene basalt (Qb); Plio-Pleistocene basalt (Tb); northwest-trending lines are faults (dotted where concealed).



**Figure 22.** Index map showing location of Indian lands in the Basin and Range Province, California.



**Figure 23.** Geologic map of the Big Pine Indian Rancheria and surrounding area (from Bateman, 1965). Recent alluvial fill (Qal); younger alluvial fan deposits (Qyf); older dissected alluvial fan and lakebed deposits (Qof); basalt flows, probably of late Pleistocene age (Qyb). Ball on downthrown side of faults.

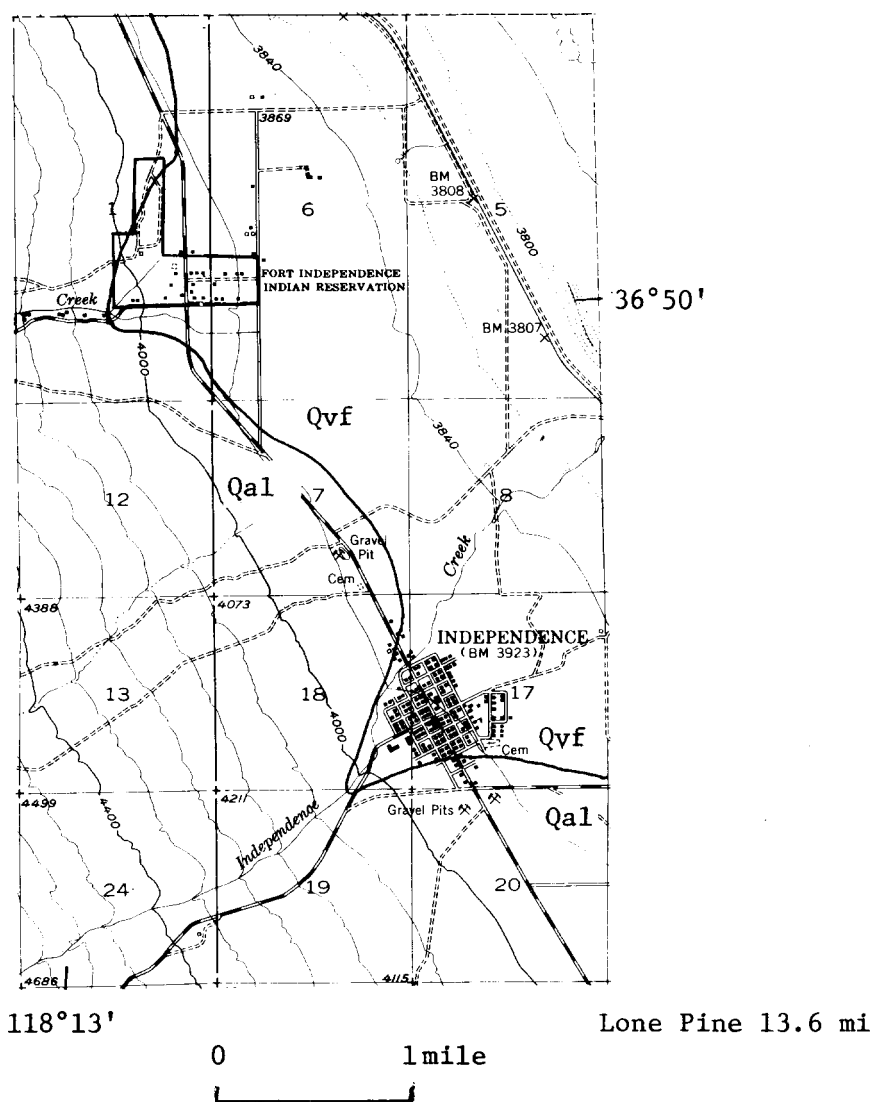


**Figure 24.** Geologic map of the Bishop (Paiute-Shoshone) Indian Reservation and surrounding area (after Bateman, 1965). Recent alluvial fill (Qal); younger alluvial fan deposits (Qyf); Pleistocene terrace gravels (Qg); older dissected alluvial fan and lakebed deposits (Qof).

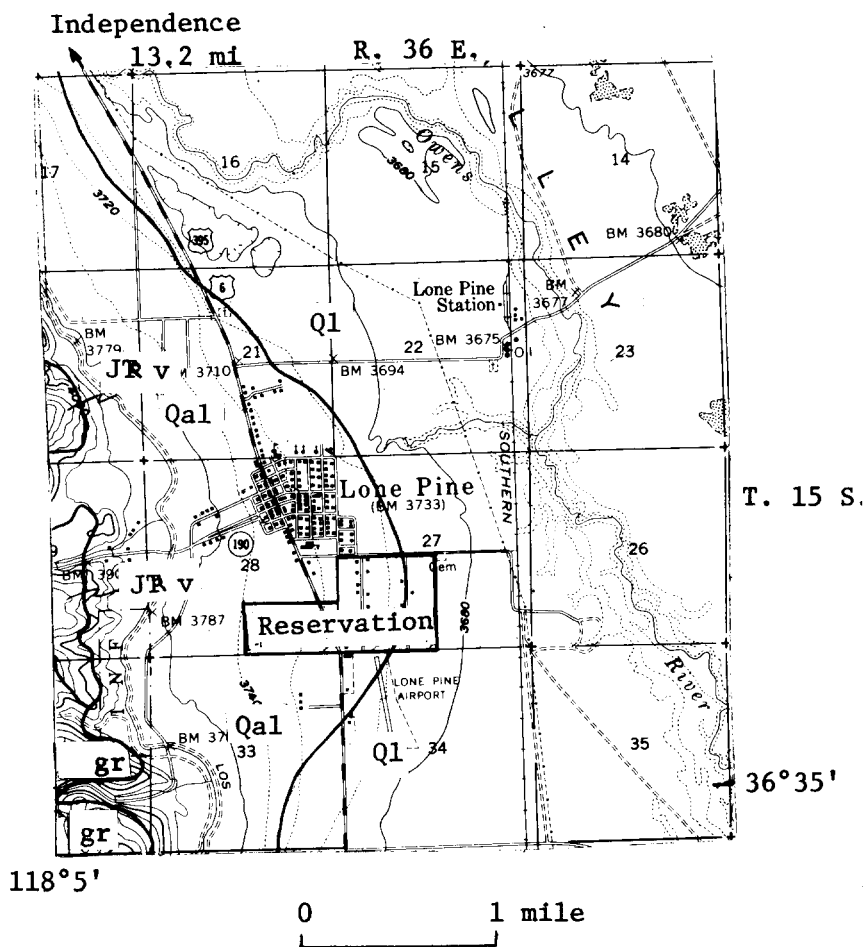
Big Pine 21.6 mi

R. 34 E.

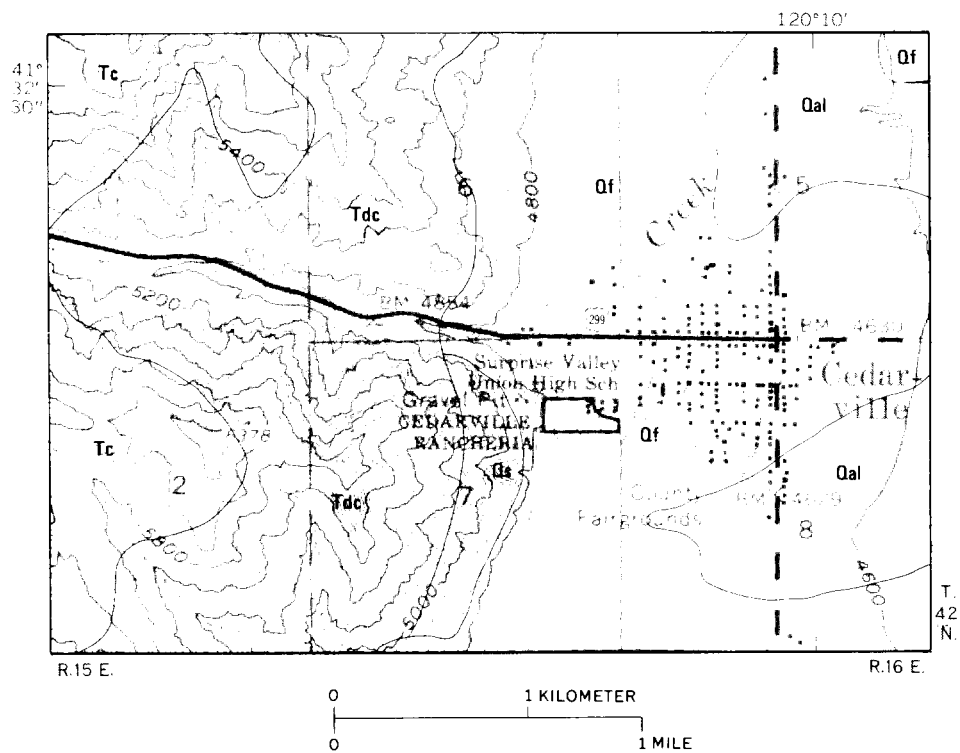
R. 35 E.



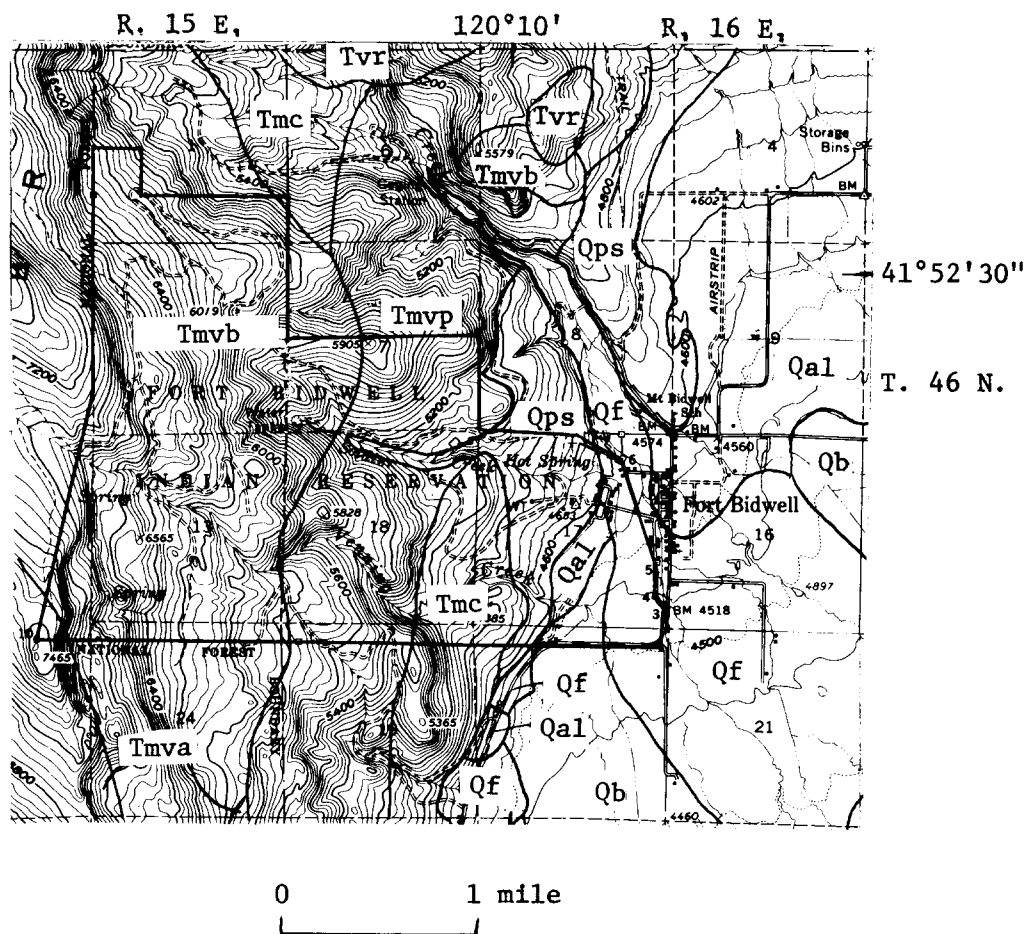
**Figure 25.** Geologic map of the Fort Independence Indian Reservation (after Ross, 1965). Recent valley fill (Qvf); Recent alluvium in fans and stream deposits (Qal).



**Figure 26.** Geologic map of the Lone Pine Indian Reservation and surrounding area (from Matthews and Burnett, 1965). Alluvium (Qal); lake deposits (Ql); Mesozoic granitic rocks (gr); Jurassic-Triassic metavolcanic rocks (JTv).



**Figure 27.** Geologic map of the Cedarville Rancheria and surrounding area (from California Department of Water Resources, 1963). Recent alluvium (Qal); alluvial fans (Qf); Pleistocene near-shore deposits (Qs); Miocene Cedarville Series (Tc); Oligocene Deep Creek Conglomerate (Tdc).



**Figure 28.** Geologic map of the Fort Bidwell Indian Reservation (from California Department of Water Resources, 1963). Recent basin deposits (Qb); alluvial deposits (Qal); alluvial fans (Qf); near-shore deposits (Qps); Miocene basalt (Tmcb); Miocene andesite (Tmva); Miocene pyroclastic rocks (Tmvp); Cedarville Series (Tmc); rhyolite (Tvr).